COLLEGE OF ENGINEERING CORNELL UNIVERSITY

The Cornell engineer

FEBRUARY, 1952

VOL. 17, NO. 5

25 CENTS

Founded 1885

THE CORNELL

engineer

FEBRUARY, 1952 VOLUME 17 NUMBER 6

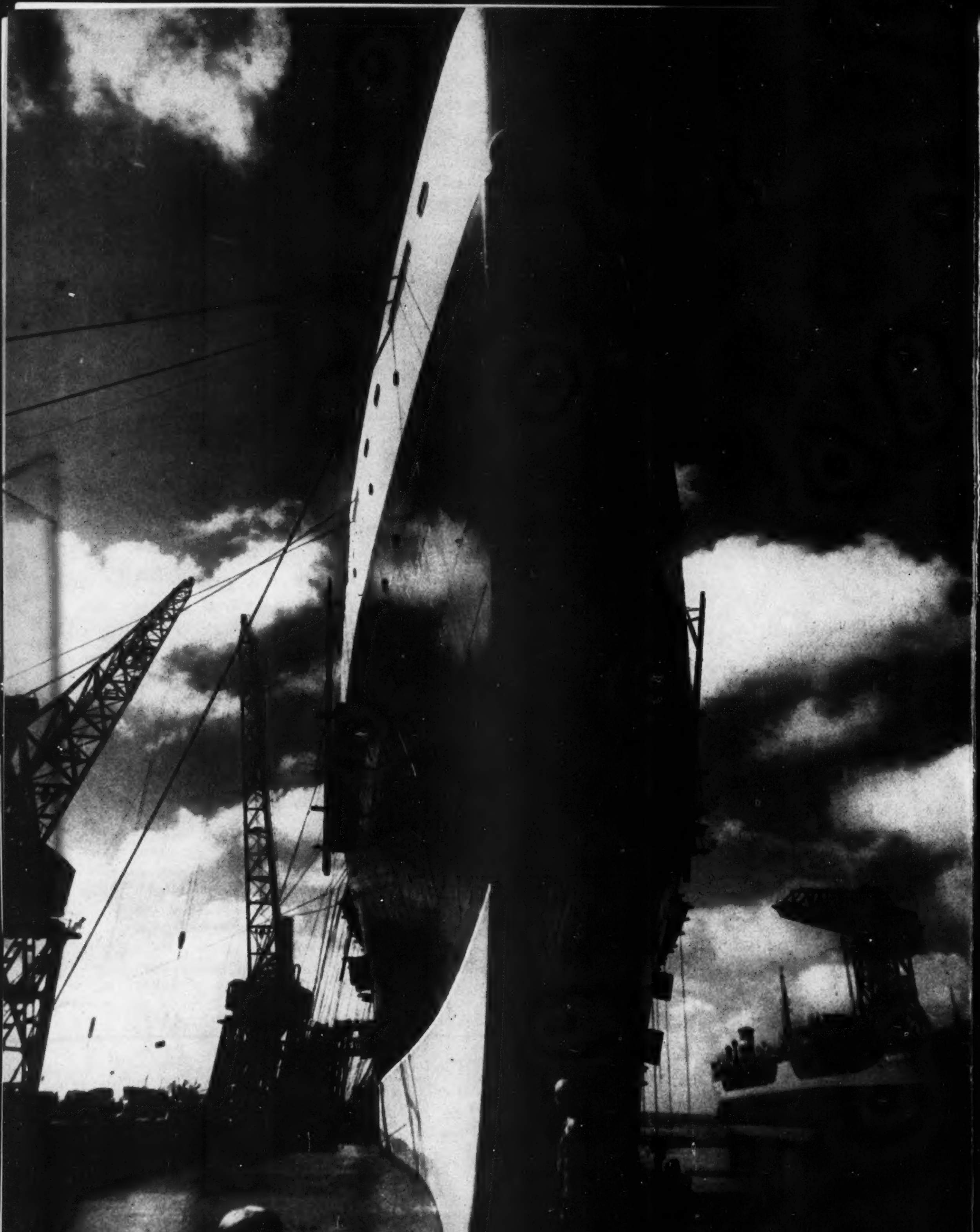
COVER: Spring Registration—"And how many eight o'clocks do you have?"

—*Critchfield*

Member of The Engineering College Magazines Associated
Chairman: Prof. John Paustian, University of Nebraska, Lincoln, Nebraska
Publishers' Representative, Littell-Murray-Barnhill, Inc.
101 Park Ave., New York and 605 N. Michigan Ave., Chicago

Published monthly—October to May—by the Cornell Engineer, Inc., Lincoln Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00 (See President's page); student $1.50; single copy $.25.



CRANES THROUGH THE AGES

HOWARD C. YOUNG, M.E. '19

Anyone who has ever seen locomotives being loaded out by a crane for overseas shipment will never forget the spectacle. He may have been making a habit, since childhood, of viewing construction projects in his own community, enjoying the thrill of seeing heavy steel beams and girders raised almost miraculously to the upper floors of high office buildings and warehouses. But seeing a 100-ton floating crane lift a full sized locomotive off a wharf without apparent effort and load it gently into a ship's hold is an experience warranted to make even the most experienced "sidewalk superintendent" marvel. If he is an engineer, he will realize that the goliath of floating cranes at which he is looking embodies just about the ultimate in today's engineering knowledge in the fields of cantilever truss design, self-contained diesel-electric power plants, and electric controls.

Crane designers are doing wonderful things today. Only a few years ago, a 450-ton twin crane was installed at a Naval shipyard in this country, but larger, more flexible, more efficient cranes are already taking shape on that industry's drafting boards. Today's cranes represent tremendous progress on the long road of development in weight-lifting—a road which extends back 5,000 years into antiquity, to the time when kings built great tombs of heavy stones which first had to be transported long distances, then elevated into place by the labor of thousands of human slaves. The history of cranes forms an excellent base on which to build a knowledge of mechanical and electrical engineering and for acquiring some fundamental principles of civil, structural, and marine engineering as well.

The $70,000,000 ship S.S. United States nears completion at Newport News. Able to accommodate 2000 passengers and a crew of 1000 in peacetime, the vessel could, in time of emergency, be concerted into a troop transport capable of carrying 14,000 men 10,000 miles without stops for fuel, water, or food. —*Westinghouse*

Oldest Hoisting Device

Our oldest record of a hoisting device is an Assyrian bas-relief about 4,000 years old, now in the British Museum. It shows a warrior outside a besieged castle cutting a rope to which the defenders had attached a bucket and were trying to draw up water. The rope ran over a pulley-block, a device known to the ancient Egyptians and probably also to the ancient Chinese. The first recorded machine for lifting was the "shadoof," a simple appliance used by the Assyrians even before written history began. This was an early form of counterpoised sweep, similar to that used even today in Egypt and by other Mediterranean ancient folk for raising the life-giving water to irrigate crops in outlying areas while the Nile sank below the level of the fields. A lift of about 5 to 15 feet was possible with the shadoof; for greater lifts double and triple shadoofs were employed.

China—The Water Wheel

An improvement on the shadoof for lifting water was the water wheel, used in China for several thousand years and still in use there. It carried a number of bamboo cups in oblique position on the circumference of an undershot wheel which, when dipped into a stream, raised the water and emptied the cups into a trough while in the highest position. Later, in Egypt, the "saqquieh" was used to save human labor. In this machine were wheels geared into other wheels at right angles and arranged to elevate an endless chain of rope and pitchers; the device was operated by a harnessed animal, usually a buffalo, going round and round a fixed pole. The saqquieh is said to have been introduced into Egypt by the Persians, in 527 B.C., and it is still used there.

How Were The Pyramids Built?

Historians differ in their beliefs as to whether or not weight-lifting machinery was employed in the building of the Pyramids. These huge tombs, erected about 3,000 to 2,750 B.C. by Egyptian kings as future memorials to themselves, certainly required great ingenuity and mechanical skill for raising heavy stones and granite blocks into their proper places, but no indication of the mechanical contrivances used in their construction has been left. Coguet believed that the "engines" mentioned by the historian Herodotus (484-425 B.C.) for "raising the stones from layer to layer" were an early form of the shadoof, with a rotating movement added. He concluded that a number of those primitive cranes were placed in pairs on the lowest tier, and so on, tier by tier, until the top was reached. The levers were operated, he believed, by a number of men holding and pulling on the ropes. Other researchers, like Commander F. M. Barber, U.S.N., writing in 1900, reported that the Pyramids were built by the use of large inclined planes, perhaps 5 miles in length, and that no labor-saving machinery was used. Still others who have visited Egypt to study the Pyramids felt that mounds of sand, sometimes faced with brick, and wooden frameworks, or "rockers," combined with levers and blocking, were used to raise the stones in those remarkable structures. But by whatever method they were built, the Pyramids represent the earliest known important buildings for which heavy weights were moved into place.

Archimedes Lifted Weights

Archimedes (287-212 B.C.), the

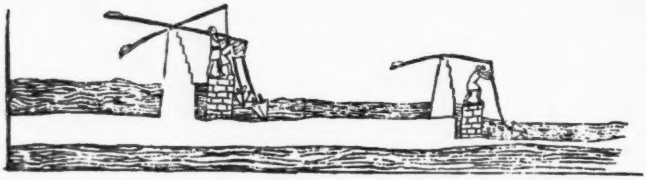


Fig. 1. A double shadoof used by the Assyrians about 2400 B.C.

Babylonian Post-Dispatch

greatest mathematician and scientific writer among the ancients, made important contributions to the development of weight-lifting equipment. He invented the compound pulley, and was the first man to realize the enormous power that can be exerted by levers. The simple machines such as the lever, the wheel, the inclined plane, the screw, and the wedge, had been known for ages, but Archimedes utilized these principles and invented machines which to the eyes of the people of his day seemed supernatural. Once, to demonstrate the power of the pulley and lever, he used a tackle and capstan to haul a ship out of water and up on the beach while operating the device at a distance, holding only the head of the pulley in his hand and drawing leisurely on the ropes. He also devised machines of war known as "trebuckets" that shot immense stones from powerful spring levers. According to Plutarch, he used similar machines which "lifted the enemy's ships high into the air by an iron hand or beak like a crane's beak, and when they had drawn them up by the prow and set them on end upon the poop, plunged them to the bottom of the sea." The Archimedean Screw, a machine for raising water, is said to have been invented by Archimedes. That was simply a water-tight cylinder enclosing a helix with a half turn of its lower, open end immersed in the water. By turning the machine, water was lifted mechanically. (Incidentally, it was the first form of mechanical conveyor of the type we know today.)

Romans Used The Gin

According to the engineer Vitruvius, the early Romans, who had a considerable amount of technical knowledge, used tackles, capstans, levers and cranes in constructing their buildings. They used the gin around 24 B.C. for operating cranes and the other lifting devices of their day. The gin consisted of an upright wooden axle to which was fastened a hollow wooden cylinder, or cake, around which a rope wound horizonally; the ends of the rope were supported by pulleys over which the load was raised and lowered. A beam 7 or 8 yards long was fastened transversally across the vertical axle, and a horse was harnessed to each end of the beam. One theory of the origin of the term "horsepower" is that an ordinary horse, traveling at the steady rate of 2 1/2 miles per hour, or 220 feet per second, could pull a steady load of about 150 pounds, which is equivalent to 33,000 foot-pounds per minute, or one horsepower.

Dutch Shippers Used Quay Cranes

The Dutch are credited with having first used mechanical weight-lifting devices commerically on a broad scale. Around 1700 their river and ocean shippers employed a crude, complicated form of crane on quays for loading and unloading merchandise. The British borrowed the idea and used a number of those devices on their wharfs in the eighteenth century. Many of these were operated by men walking on steps inside the periphery of a large hollow wheel. The wheel of those primitive cranes was about 15 feet in diameter. The rope was wound upon an axle about 14 inches in diameter, then passed over guide rollers to the jib of the crane which projected out over the hatchway of the ship. The jib was pivoted and could rotate about 270 degrees to deliver goods upon the quay. To land the goods the man in the crane walked backwards, which was dangerous and caused numerous accidents.

The first improvement in those early cranes was to reduce the large wheel in size and fix it upon the jib, thus liberating the man. The upright post was fixed in the ground and its top equipped with a pivot upon which the jib turned.

Fig. 2. Early walking crane, used on quays by the Dutch and English from 1700 to 1800.

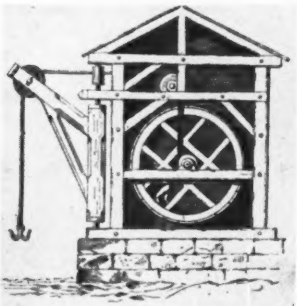


Fig. 3. Placing the wheel on the jib and liberating the man was the first improvement on the walking crane.

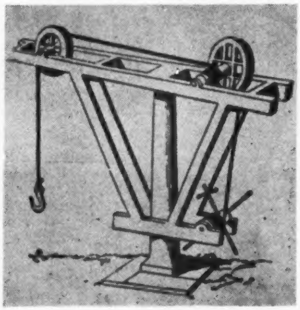
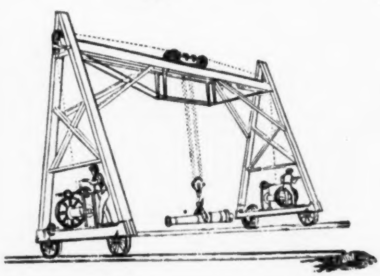


Fig. 5. Early hand-powered crane, about 1850.



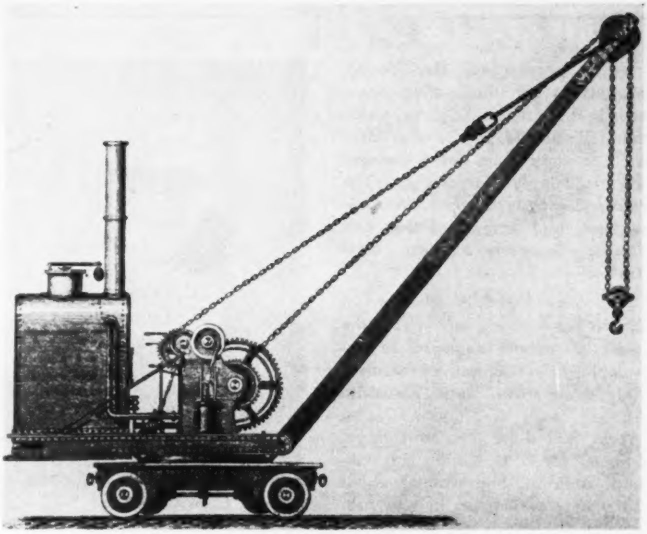
Up until about 1850 all cranes were made almost entirely of wood, but as time passed individual cast iron sections were employed and chains substituted for the ropes. After 1850 most cranes were made of iron.

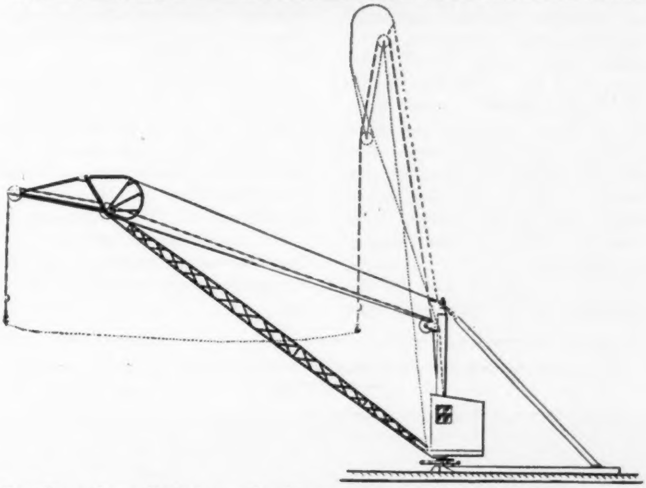
The industrial revolution in Europe saw several forms of cranes used in foundries. Probably the simplest form was the smithy crane, where a single tie rod supported a horizontal track allowing the pulley blocks to travel between the smith's hearth and the anvil, the entire assembly being supported either by a wall or by the steel post to which it was pivoted. The pulley block was slung from a light trolley, which was traversed by simply hauling on the block chain.

The First Locomotive Cranes

Commander Barber, U.S.N., in his book, "The Mechanical Triumph of the Ancient Egyptians," describes the first models of locomotive cranes. He credits Henry Maudsley of England with building the first locomotive crane in 1811. That crane was operated by hand power. Commander Barber further states that it has been established that James Taylor of Birkenhead, England, was building steam derricks in 1839. These were pillar cranes having a fixed radius wooden jib and post. They had a single steam cylinder and were designed for use in a stone quarry. In 1853 Taylor patented an improved steam winch with a link reversing motion, double cylinders, and no flywheel.

Appleby Brothers of London built their first steam cranes independently and at about the same time as Taylor, but they reached the market a few months later than his. Appleby hand cranes were exhibited at the International Exhibition at London in 1851, and their steam cranes at Paris in 1867 and Vienna in 1873. There is evidence to indicate that Taylor's travelling jib crane, made in 1859 or 1860, may have been the first successful crane of that type. Incidentally, the first steam locomotives of American manufacture appeared in 1880 when the Industrial Works of Industrial Brownhoist Corporation made a standard guage railroad steam shovel. That was followed in 1886 by their 20-ton steam wharf crane mounted on a four-wheel railroad car.





Top: Fig. 4. James Taylor's traveling jib crane, made in 1859 or 1860. Bottom: Fig. 6. Special crane, giving level travel, made about 1880 by Babcock and Wilcox.

Overhead traveling Crane

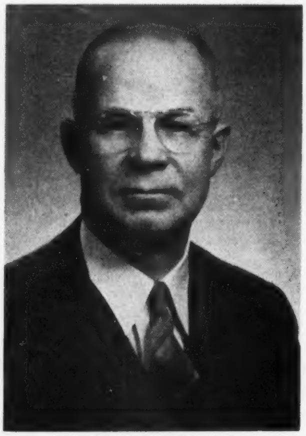
Figure 5 shows an early hand powered travelling crane that came into use in England about 1850. This type of crane was originally used to move heavy mahogany logs in lumber sheds, travelling across the shed on wheels and tracks. It was operated by workmen standing on the crane at each end, as shown. Several of these cranes had to be used for long sheds, however, which was a disadvantage. Later, framework to carry the railway was installed along the full length of the inside walls of new buildings. One crane could then cover the entire floor area by moving along the length of building while the carriage was travelling across it. This gave an extremely useful machine; it was forerunner of our present-day large overhead cranes. It is belived that the first overhead crane of this type was built in England in 1850. That one was operated by steam. Unfortunately, the manufacturer's name has not been recorded.

Simple hand cranes are still used

THE AUTHOR

After graduation, Mr. Young worked as an illuminating engineer in the lamp and lighting field, being employed by General Electric Company (Nela Park), General Electric Supply Corporation, The Miller Company of Meriden, Connecticut, and Associated Gas and Electric Company, Elmira, New York.

He was Lighting Director at Elmira for 4 years, supervising the work of people engaged in developing the Company's residential, commercial, and industrial lighting loads in 3 states. During World War II he was Educational Director for C. G. Conn., Ltd., Elkhart, Indiana, and trained about 2000 new employees in war production operations for manufacturing aviation precision equipment (horizon-gyros, altimeters, and special parts) for the United States Army and Navy. He also taught 12 Purdue ESMWT courses there for the firm's technical personnel, including mathematics, engineering physics, engineering drawing, production methods, time and motion study, and quality control. Since 1946 Mr. Young has been located in Washington, D. C., employed first as an engineer with the Department of the Navy and after



H. C. Young

January 1951, as Chief of the Manuals Section, Federal Civil Defense Administration.

He is chairman of the Finance Committee of the Washington Chapter of the American Society for Safety Engineers. Among his government publications are "Safe Work Practices in the Naval Shore Establishment," "Instrumentman 3 & 2," and "Instrumentman 1 & Chief," new engineering training courses for Navy enlisted personnel.

Fig. 7. U.S. Kearsage crane undergoing a 250 ton test. This is an example of a sea-going crane.

—*Wellman Engineering*

in all countries for occassional service, such as the transportation of baggage and freight at railroad stations, where it would be impractical to employ a larger, more expensive crane. They are usually mounted on a four wheeled truck or small flat car. These hand cranes generally employ a counterbalance to make them stable in operation. In the early models the balance weight was usually fixed at constant radius, although some had balance boxes fitted with rollers by which the box and its weight could be moved inward or outward to accomodate various loads.

Rope Driven Traveling Crane

A form of power crane popular in England about 1865-1867 was an arrangement for transmitting power in which an endless rope, driven continuously at high speed in a foundry, could be made to give motion to any part of a crane by placing the rope in contact with grooved pulleys of various diameters. The moving rope could give the crane either longitudinal or transverse motion, or it could furnish power for hoisting. This scheme had the advantages of economy and cleanliness, and the crane's parts could be made of lighter metal than usual, since the source of power was not carried by the machine itself. These early travelling cranes, commonly called "fly-rope cranes," were also used on English docks and wharves and at locomotive factories.

Lever Derrick Crane

Babcock and Wilcox, Ltd., England, introduced an unusual type of derrick crane in 1880. They first had that special feature which has since been utilized successfully in level luffing wharf cranes. A twin quadrant lever was hinged to the jib ahead of the mast and tied to the mast top by a pair of guy ropes. This gave almost level luffing movement to and from the mast, and had the additional advantage that the speed of the horizontal motion *decreased* as the smallest radius was approached. Luffing was accomplished by a single hand lever on those early models. Later, in 1923, a linkage was added to the boom of these machines which gave them maximum speed at the

(*Continued on page* 32)

CATIONIC DETERGENTS II

THOMAS W. WEBER, ChemE '53

(In the December issue the author discussed the general history and uses of the cationic detergents. He concludes with a description of their chemistry and industrial technology.)

A discussion of the principal types of cationic detergents will be helpful before taking up the raw materials of their manufacture. The cationic portion of the detergent molecule may vary considerably as illustrated by the following types.

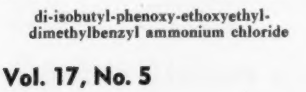
I—Non-Cyclic Type. The general formula may be represented as:

$$\left[\begin{array}{ccc} & R_2 & \\ & | & \\ R_4 - & N & - R_3 \\ & | & \\ & R_1 & \end{array}\right]^{+} X^{-}$$

R_1, R_2, R_3, and R_4 represent organic radicals or chains and X the anion, usually a halide.

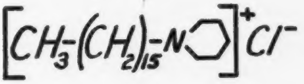
In the simplest type R_1 is a long aliphatic chain, while R_2, R_3, and R_4 are methyl, ethyl or other short chain groups; for example, cetyltrimethyl ammonium bromide. Both R_1 and R_3 can be long aliphatic chains giving dialkyl dimethyl ammonium compounds. Another variation is where R_2 and R_4 are methyl groups and R_3 is a benzyl group, giving alkyl dimethylbenzyl ammonium compounds, e.g., cetyldimethylbenzyl ammonium chloride.

II—In this group the long alkyl group contains unsaturated linkages or in others, an aromatic ring. For example, diisobutylphenoxy, ethoxyethyldimethyl-benzyl ammonium chloride.



di-isobutyl-phenoxy-ethoxyethyl-dimethylbenzyl ammonium chloride

III—Cyclic Type. Three of the nitrogen valency bonds from part of a cyclic compound, e.g., cetyl pyridinium chloride and laurylisoquinolinium bromide.



Quaternary ammonium compounds lead the field both in number and tonnage. The other cationic detergents are quite diversified in chemical make-up and processing methods. Therefore the center of the discussion will be on the "quats". The quarternary ammonium compound is built around a nitrogen atom which is pentavalent, four of the valencies being attached directly to adjacent carbon atoms of organic radicals and is represented by Type I.

Fats and Fatty Acids

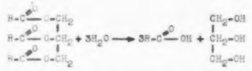
Fats are a basic raw material for cationic detergents, as for the manufacture of soap. Fats are important because they furnish the alkyl (R) groups. They are for the most part mixtures of glyceryl esters of fatty acids. These mixtures generally contain at least five, and frequently more, different fatty acids and only small percentages of simple triglycerides (such as triolein) and are usually highly heterogeneous. The particular acids found are influenced by environment, fats from land animals containing large amounts of C_{16} and C_{18} saturated, and unsaturated acids.

Palmitic acid is the most abundant and widely distributed of the naturally occurring saturated fatty acids. Nearly all fatty substances which have been studied have been found to contain it to some degree. All animal life and many vegetable fats and waxes contain stearic acid. From the commercial standpoint, oleic, linoleic, and linolenic acids are the most important unsaturated acids. In general, the fatty acids present in animals have no more than eighteen carbon atoms in a series; a few notable exceptions are those acids found in some marine life and insects. Acids containing less than sixteen carbon atoms in a series are quite often found in vegetable oils.

One pure fatty acid is never found alone in a fat. When one member of a series of saturated fatty acids is found to a considerable extent, the homologs above and below it in the series are also found in measurable amounts. The present conception of the structure of naturally occurring fatty acids is that they have normal unbranched chains of carbon atoms. The only naturally occurring fatty acids always contain an even number of carbon atoms; thus the long chain alkyl groups of quaternary ammonium compounds will always have even numbers of carbon atoms.

Conversion of Fats to Acids

Fatty acids are converted from fats, or glycerides, by the old soap-kettle procedure of saponification or by other new splitting methods. Most of the commercial fatty acids made in the United States are prepared by one of the four following processes: (1) The high pressure autoclave batch process which is the oldest, (2) the Twitchell batch process, in which water and a catalyst are used, (3) a continuous, countercurrent process found in two modifications, the Proctor and Gamble and the Colgate-Emery and (4) a continuous concurrent process. The products of this splitting are fatty acids and glycerol:



Glyceride → Fatty acid + Glycerol

The commerically more important fatty acids are difficult to separate. Saturated acids can be separated from unsaturated by crystallization and acids of different chain length are separated by fractional distillation.

Conversion to Primary Amines

The ease with which fatty acids undergo reaction usually decreases with the length of the carbon chain. The formation of quaternary ammonium compounds requires a primary amine, and the problem therefore is to convert the fatty acids into primary amines.

The acids are first reacted with ammonia to form ammonium salts, which on heating lose one mole of water to yield amides:

$$R\text{-}C(=O)\text{-}OH + NH_3 \longrightarrow R\text{-}C(=O)\text{-}ONH_4 \xrightarrow{\text{heat}} R\text{-}C(=O)\text{-}NH_2 + H_2O$$

Acid → Ammonium salt + Amide

By heating amides to high temperatures, there are formed nitriles, along with fatty acid and ammonia. In the presence of excess ammonia, the fatty acid is again converted into an ammonium salt and the process is repeated until eventually the conversion to nitrile is quantitative:

$$2R\text{-}C(=O)\text{-}NH_2 \xrightarrow{\text{heat}} R\text{-}C{\equiv}N + R\text{-}C(=O)\text{-}OH + NH_3$$

Amide → Nitrile + Acid

The next reaction is:

$$R\text{-}C(=O)\text{-}OH + NH_3 \longrightarrow R\text{-}C(=O)\text{-}ONH_4 \longrightarrow \text{as shown above}$$

Acid → Ammonium Salt

Commercial Production Processes

The catalytic addition of two moles of hydrogen to the nitrile yields the desired primary amine:

$$R\text{-}C{\equiv}N + 2H_2 \xrightarrow{\text{catalyst}} R\text{-}CH_2\text{-}NH_2$$

Nitrile + Hydrogen → Primary Amine

The quaternary ammonium compounds are then easily formed through the reaction of three moles of an alkyl halide, methyl chloride, for example:

$$R\text{-}CH_2NH_2 + 3CH_3Cl \longrightarrow [R\text{-}CH_2\text{-}N(CH_3)_3]^+Cl^- + 2HCl$$

Amine + Methyl Chloride → Quaternary Ammonium Salt

All of the above series of reactions with the exception of the last one are carried out by Armour and Company at their new plant (1949) at McCook, Illinois. Their processes will be briefly described in the paragraphs which follow. Although the processes used to convert fats into quaternary ammonium compounds differ among the various manufacturers, those used by Armour and Co. can be said to be typical and general.

Raw Materials Receiving—The primary raw materials used at this plant—fats, sodium hydroxide solution, ammonia, acetic acid, and sulfuric acid—are shipped by railroad tank cars.

The fats are stored in large tanks constructed of steel with capacities of 1,000,000 pounds. The fats used are for the most part tallow, greases which include lard and other packing house fats, fish oils, and coconut oils.

Fat Refining—Before being hydrogenated, animal fats and fish oils are usually refined, while vegetable oils, such as coconut and palm, are sent directly to the hydrogenation vessels.

Fats are refined in a dilute alkaline solution, which removes any free acids. The acid-free oil is then sent to a bleaching tank, heated to drive off moisture, stirred with bleaching clay, and passed through a vertical plate filter. The oil is then ready for hydrogenation.

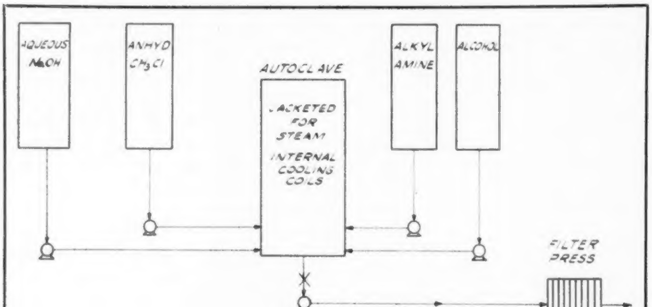
The residue oil in the refining kettle is drained to an acidulation tank and then added to unrefined oils, the mixture being sent to the splitting tower.

Fat Hydrogenation—Because of the tremendous fire hazard involved in hydrogenation, Armour has placed their hydrogenation vessels outside of the hydrogenation building. These five vessels have a charge capacity of 10,000 pounds each, are constructed for agitation of the reacting mixture, and have internal heating and cooling coils. Two vessels are used for fats and fatty acids, one for fats and oils, and the remaining two for the reduction of nitriles to amines. Inside the hydrogenation building, the catalyst is prepared, and the necessary pumps, filters, and controls are housed.

Hydrogen is prepared by the catalytic reaction of natural gas and steam. Carbon monoxide present in the hydrogen is converted to carbon dioxide by the water-gas shift reaction. After cooling, the carbon dioxide is removed by scrubbing the gas with monoethanolamine. The natural gas used contains nitrogen which remains mixed with the hydrogen, but this nitrogen does not interfere with the hydrogenation. The hydrogen plant has a capacity of 300,000 standard cubic feet per day.

The catalyst used is reduced nickel formate. The weight of catalyst used (calculated as nickel) is 0.25%. Pressures of around 250

(*Continued on page 46*)

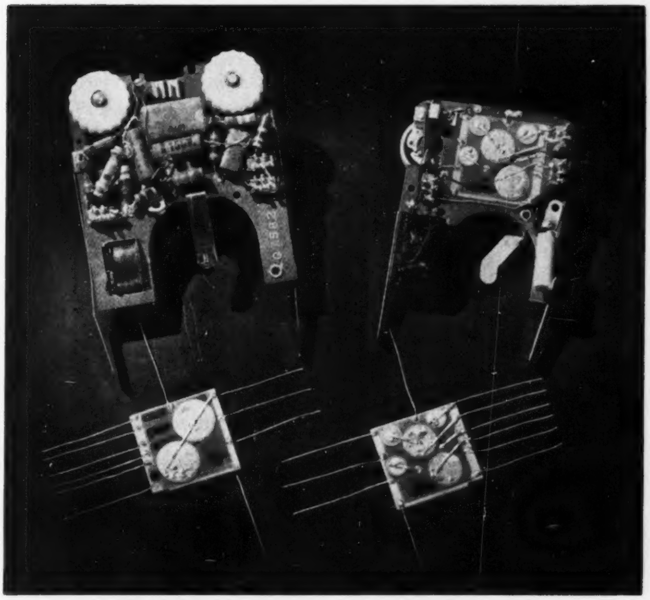


PRINTED CIRCUITS

HENRY F. DIMMLER, EE '54

Gulliver's Lilliputian world might have been small—but it holds nothing over products of modern-day electronics industry. With subminiature electron tubes, transistors (CORNELL ENGINEER, Dec. 1951) and printed electrical circuits, electronics engineers have succeeded in cramming all the components of a radio transmitter, receiver and power plant into the nose of a 75 mm artillery shell.

The field of minicam electronics was officially born back in the darker days of World War II. Army Ordnance men wanted a shell with a "brain." The electronics industry, under a shroud of secrecy, set to work on the problem and came up with the proximity fuze—a combination radio transmitter and receiver which would cause the shell to explode just at the right moment for greater effectiveness. The great problem which had to be solved in this case was that of size. It is no mean task to fit a complete transceiver into a space the size of a pack of cigarettes. Tubes could and were being made smaller, but what about other circuit components—resistors, capacitors, inductors, and the wiring itself?



Top left: a hearing aid using conventional components. Top right: the same, using a printed chassis. Bottom: The two sides of the same printed circuit.
—*Centralab*

Solution of Wartime Problems

The solution was found in printed electrical circuits—something which research men had been toying with for some time, but which they had never considered practical. In one fell swoop, the electronics industry provided the subminiature components for the proximity fuze, but more important still, came up with a method of circuitry which promised reduction of many circuits to essentially two dimensions, concurrent with numerous manufacturing advantages not then being realized in conventional circuit production.

Since the war's end and subsequent release by the government of printed circuit information and techniques, radio electronics manufactures have adapted printed circuits to almost every conceivable application. Resistor - capacitor units such as filters and interstage coupling circuits, and multi-stage amplifier circuits are particularly successful applications of this electronic miniaturization. Despite the fact that size reduction is the main attraction in the use of printed circuits, several other advantages make their utilization of even more attractive proposition to manufacturers. Uniformity of production, reduction of assembly and inspection time, lower costs, and reduction of line rejects provide for greater savings even in those applications when size reduction offers no advantages. Present assembly-line techniques cause wiring and soldering processes to be a major part of the total operation. Even small radio sets have over 100

soldered connections while a large television receiver may have well over 500 soldered connections. New circuit printing processes cut these solder operations by as much as 60 percent. A single operator may turn out thousands of printed circuit plates on a production line basis in one day. The degree of mechanization possible on a printed circuit assembly line is illustrated by one English electronics firm which is using a completely automatic machine to turn out a fully wired (printed) circuit stage every 20 seconds.

Printing Developed

As a result of the extensive wartime research in this field, several possible methods and processes of producing printed electrical circuits were developed. Of these, the more practical and widely used methods include printing, spraying, chemical deposition, vacuum processes, die-stamping and dusting. All are methods of producing an essentially two-dimensional electrical circuit on a thin, non-conducting surface and as such, fall under the general classification of electrical circuit printing processes. Actually the main difference in these processes is the manner in which the conductors are produced. Circuit elements (capacitors and resistors) are in general produced by processes which are used inter-changeably with any of the above conductor-printing methods.

Base Plate

The insulating base plate is the first step in the manufacture of the printed electrical circuit. This base plate may be either ceramic or some type of high-dielectric plastic. Care must be taken in selecting a base plate suitable for the particular circuit application and printing technique. For example, a ceramic base plate must be used in those circuits which require high temperature firing as part of the manufacturing process, whereas a plastic would be used in cases where workability is a desired characteristic. In many cases the insulating surface is treated to improve adhesion of the circuit elements to it. Roughening of plastic surfaces is achieved by sand blasting while ceramics and glass are etched lightly with acidic fumes prior to printing. Since absolute cleanliness is necessary for a good bond, all base plates are thoroughly cleaned in a suitable solution. The base plate is then ready for application of the circuit to its surface by one of the six printing methods now in use.

Paints and Painting Methods

Painting is perhaps the most widely used of the six general methods for producing printed circuits. Paints for both resistors and conductors are available commercially and produce excellent results when properly applied. In general, the painting of conductors closely follows the process used by pottery manufacturers—metal oxides containing ceramic fluxes are burned onto hard insulating surfaces. However, the difficulties involved in producing paints of sufficiently high conductance and adhesion make this printing method more than just a simple pottery process.

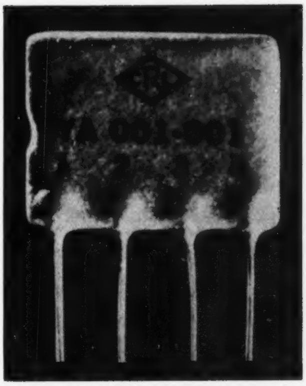
Paints for printed circuits are comprised of selected combinations of constituents including pigments, binder, solvent, reducing agent and filter. The pigment is the conducting material for the circuit wiring. Powdered silver, silver oxide, silver nitrate and various organic silver combinations are generally used for this purpose. The binder serves to hold the pigment together, provides good workability, and also binds the pigment to the base plate. The purpose of the solvent is to dissolve the binder and adjust the viscosity of the pigment-binder mixture. The common aromatic and aliphatic solvents serve this purpose quite well. A reducing agent is employed to reduce the metallic compound of the conducting pigment to pure metal. It should be noted that this reducing agent is only necessary in those cases where the base material will not stand high firing temperatures (i.e. plastics). The high firing of circuits printed on ceramics will bring about the same reduction effect without an added reducing agent. The filler is usually an inert material such as powdered mica or mineralite whose sole purpose is to spread the pigment particles, thus increasing electrical resistance. It is sometimes desirable to add a flux to the circuit paint in order to improve the paint-insulator bond.

Resistor paints are of the same general composition as conductor paints with the exception of the pigment which is usually in the form of a high resistance carbon black, powdered graphite or a metallic salt. The ingredients are mixed in varying proportions to produce resistance ranging from a few ohms to hundreds of megohms. However, the paint composition, length, width, and thickness of the painted resistor all closely govern the value of resistance finally obtained. It can be seen that great care must be exercised in painting resistors when close tolerances are desired.

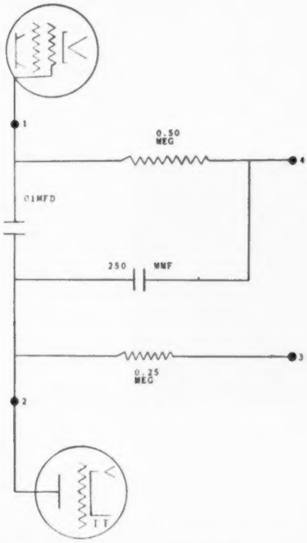
Application of Paints

In the actual application of paints to the base plate it is of course necessary to follow accepted wiring practice. Components must be arranged in such a manner that they do not affect each other adversely. In addition, it is desirable to eliminate need for cross-overs in as many places as possible. Where a cross-over is necessary, the usual practice is to go through the base plate to the other side or to place an insulating material between the crossed conductors. Where high precision is not necessary the paint may be applied with a regular paint brush. Closer tolerances demand greater care in application by brushing. Stencilling is gaining wide acceptance as the best method of applying paints quickly, uniformly and to close tolerances. Screens of silk or metal, with the circuit configuration blocked out, are used for mass-production circuits in this manner. The screen is placed over the dielectric base plate and a roller containing the conducting paint is moved across the stencil top, leaving a uniformly printed circuit on the base plate. Several other methods of applying the paint have been used experimentally, the most notable being a process which uses a conventional printing press to "print" the circuit on the base plate in the true sense of the word.

After application of the paint, the entire plate is fired to reduce the pigment and to form the necessary bond between conductor and insulator. In the case of plastic bases this firing temperature is usually



Terminals 1,2,3, and 4 of the coupling circuit below are the leads of the printed circuit above. Area equals one square inch.
—*Centralab*



"Pelleting" is the preparation of ceramic base plates for the printed circuits.
—*Centralab*

low and serves merely to strengthen the bond.

Resistors are applied in this same manner although with much greater care than in the conductor printing process. It has been found that two separate applications of resistor paints, using the stencilling method with a pressure-controlled roller, give excellent results. Production-line techniques have successfully turned out circuits with resistors of ±15 percent tolerance by this method. Those resistors requiring closer tolerance are printed manually by experienced operators and checked for precision before being approved. Several different resistor mixes are available for the various values of resistance desired in electronic circuits. Power ratings of these resistors are comparable to those of conventional resistors.

Capacitor components of printed circuits are generally produced by making use of the base plate (high dielectric constant) as the dielectric and painting silver discs of correct area on opposite sides of the plate. In those cases where the base plate is of necessity of low dielectric constant, miniature capacitors are soldered directly to a silvered area on the base plate. It is necessary to exercise care in this operation in order that dielectric is not ruptured by the high soldering temperatures. Another method in current use is to build up a capacitor on the base plate by spraying alternate layers of conducting and high dielectric paints. Tolerances of ±15 percent can be achieved on a mass-production basis using these methods.

Inductors Formed

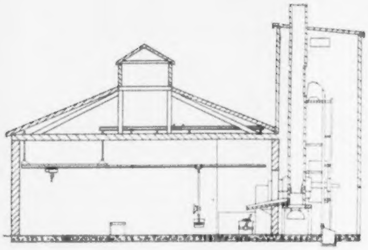
Inductors in the form of a spiral configuration are also produced by circuit printing methods. The lowest frequency for which these inductors may be printed is governed generally by the printing area available. However, inductance in smaller circuits has been increased by printing inductors in multiple layers. A layer of insulation is painted over the inductor after which additional units are successively applied using the same conventional printing methods. This multiple layer scheme is also used to print complete circuits over each other although care must be taken to insure that no undesirable couplings are thus formed. Due to the low permeability of the surrounding materials of regular printed circuits, design engineers have greatly increased circuit inductance by placing a magnetic slug in an indentation in the base plate over the inductor. Other methods of increasing permeability have been employed, but the principle is the same in most cases. One other method deserving mention here is the connecting of two coils in aiding series, thus quadrupling inductance at unity coupling. Variable inductive or capacitive coupling is obtained by arranging the components such that either or both of the inductors or capacitor plates may be shifted relative to their mates.

Spraying Circuits

Easy adaptability to assembly line practice and simplicity of operation has caused the spraying process to become an important method in producing printed electrical circuits. The same paints may be used in either the straight painting or spraying process, and stencilling is the chief method of producing the desired configuration in both cases. Spraying apparatus that will melt the metal must be used. Compressed air is them employed to atomize the molten metal and drive onto the base plate.

One spraying method of particular importance is abrasive spraying. Shallow grooves conforming to the circuit design are cut in the base plate by use of a stencil and sand blasting apparatus. The circuit components are then positioned on the base plate and molten silver or copper is sprayed into the grooves. This process provides for complete wiring and soldering of the electronic chassis in one easy operation. A completely automatic machine now turns out hundreds of circuits daily using this method of production. The latest development in spraying is the electronic method. The work and stencil, at ground potential, is carried on a conveyor belt between electrodes at a potential near 100,000 volts a.c. Paint sprayed into the area between the electrodes becomes charged to a high potential and is attracted to the work by an electrostatic force. The result is a smooth layer of conducting metal deposited on the base plate at

(Continued on page 38)



ME's, CLASS OF '53, STAND BY AS INSTRUCTOR

DENNIS J. JOYCE SHAPES THE BREAST PREPARATORY TO . . .

Tapping

CORNELL'S CUPOLA

Pictures by Robert Critchfield, ME '53

Left: Jim Beveridge, '5
...rs through the cupola
...harging door to check
...e progress of the hea...

Right: Sparks fly as the
first traces of molten ...
reach the open tapping
spout and Mr. Joyce pre...
pares to "bot up"—plug
the tap hole.

The importance of foundry work to Cornell's engineering curriculum has been recognized since the days when Robert H. Thurston was Dean of the Sibley College of Mechanical Engineering. At that time, one of the graduation prerequisites for engineers was the forging of a link chain. While today's Cornell engineer is not under obligation to forge chain, he is exposed to a comprehensive education in foundry practices—this as the result of an increased awareness of the importance of foundry techniques to industry, and recognition of the need for improvement in that field.

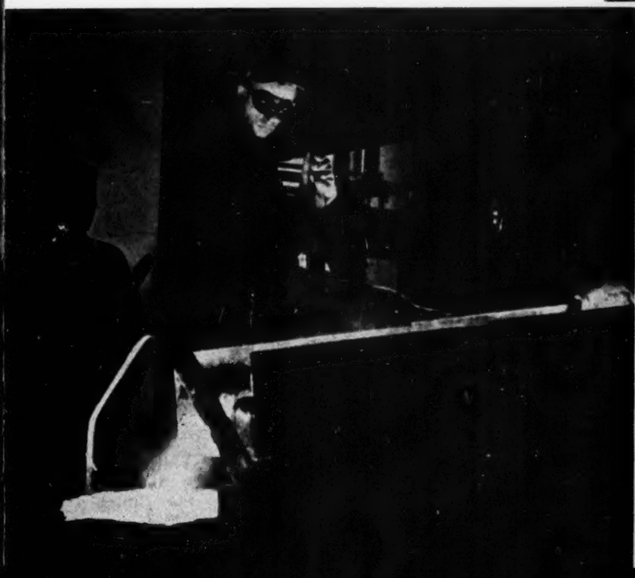
Through the years, largely with the help of its engineering alumni, Cornell has been able to build up its foundry until it now boasts a combination of completeness and utility rare among the colleges and universities of this country.

The cupola, whose operation is depicted on these pages, was donated and installed in 1940 by the Whiting Corporation. From 1947 to 1951, a gift of $30,000 from the Foundry Educational Foundation was used to purchase equipment necessary to complete the cupola installation—a Foxboro Air Weight Controller, blower, monorail system for metal handling, trolley ladle, charge weighing scales, and storage and other handling facilities.

The tapping operation recorded here was conducted last December first for the benefit of fourth-year students in mechanical engineering.

[illegible] sand from around the castings (left), and opening the doors at the bottom of the cupola to drop the charge (right) conclude the afternoon's activities.

Floor molds are poured from a trolley ladle moved into position [illegible]



[illegible]ft: Professor Malcol[illegible] Burton (left) readie[illegible] new bot while Morr[illegible] Harper, instructor, super[illegible] the tapping opera[illegible]on. John Ash (right[illegible], inspects the [illegible] of the slag notch.

[illegible]ght: Students skim sl[illegible] from the bull ladle [illegible] the metal for pou[illegible]

NEWS OF THE COLLEGE

Cornell Television

The first step towards a possible educational program television series sponsored by Cornell University and CBS-TV was taken when the University and CBS jointly announced plans for a pilot television program on film. The first film will deal with speed and safety in present day aviation, and went into production in mid-December at the Cornell Aeronautical Laboratory in Buffalo.

Concerning this venture, President Malott said it represents "a tremendous potential for bringing a great communications medium and a great University together in the public interest . . . Cornell can only be enthusiastic over the prospect of contributing to the art of television while at the same time extending its educational services, and in sense its campus, across the nation."

Close cooperation between the university and the television network will be necessary if an expanded program is to be set up. Ideas and subject matter for the films will probably originate at Cornell where experts in each particular field will contribute their knowledge towards developing the body of the film. At this point, CBS-Television would step in and provide the technical knowledge to translate the material into television suitable for public presentation. The productions would be financed by CBS-TV which would also hold all rights to the completed film.

Cornell has cooperated with CBS for the past eleven years in radio network programming, so this is not the first time the University has entered into the communications field. In fact, Cornell has applied for a television channel and is waiting for a decision from the Federal Communications Commission. A complete study of the University's communication problems by a committee of faculty members was completed recently. The committee reported to President Malott that: "A successful broadcasting operation of the future will necessarily have to include television. Television restricted to educational programs does not fit the circumstances of the University. It would be extremely difficult to organize a full daily program of educational subjects that would maintain an audience, and it would be costly . . . We believe Cornell should operate on a commercial channel providing that harmony between educational purposes and sponsored programs can be achieved."

Auto Safety Program

A new research program whose object is to provide information which will enable automobile manufacturers to make the automobile a safer form of transportation was announced recently by the University. The program stems from a similar one carried out in aviation safety by the Aeronautical Laboratory in Buffalo. To provide guidance for the program the Cornell Committee for Air Safety Research, previously confined in its work to air safety, will broaden its activities and appropriately change its name to "The Cornell Committee for Transportation Safety Research," and will have as its chairman Dr. Theodore P. Wright, University Vice-President for research.

The decision to undertake the program was motivated by two factors: the very obvious need for research aimed at reducing the number of casualties in automobile accidents; and the realization that a great deal of information gleaned from the University's air safety research could be applied directly to the automobile field.

The program will concentrate its immediate efforts towards better basic car design from the survival standpoint. Plans call for a detailed survey to determine the specific structural elements and other factors in automobiles which cause injuries and deaths in survivable automobile accidents. Contemplated research projects will study the production of safer windshields, dashboards and steering wheels and protective basic structures throughout the vehicle with safer design and shielding of dangerous objects. Findings from such research will be submitted to automobile manufacturers for use in future design.

Assistance will be solicited from the Crash Injury Research project at the Cornell Medical College, the Cornell Aeronautical Laboratory in Buffalo, and the Guggenheim Aviation Safety Center currently operating under Cornell auspices.

Vice-President Wright said, "We are convinced that a major reduction of the transportation accident casualty rate can be achieved if reasonable amounts of time, money and effort are devoted to the problem."

ASCE

G. E. Rickard is the new president of the Ithaca Section of the American Society of Civil Engineers. He is presently the superintendent of the Bureau of Water in Binghamton. Other officers elected at a meeting held in Willard Straight Hall are Prof. H. T. Jenkins of Cornell, first vice-president; J. A. Norris, Elmira, second vice-president; and Prof. J. C. Gebhard, Cornell, secretary-treasurer.

Winter Gives Paper

Prof. George Winter, head of the structural engineering department at Cornell, will present a paper on light gage steel at a professional meeting in England next September. His report on "Light Gage (Thin-Walled) Steel Structures for Buildings in the U.S.A." will be given at the fourth congress of the International Association of Bridge and Structural Engineering at Cambridge.

Professor Winter will be one of six official delegates from the American branch of the association.

He will describe work done at Cornell for the American Iron and Steel Institute to determine specifications for the design of buildings using light gage steel. Light gage steel is less than fifteen hundreths of an inch thick. It is used in buildings which have moderate loads. It also furnishes such surfaces as wall and floor panels and roof decks.

Football Players

An interesting fact brought out in light of the recent nationwide tongue-lashing taken by college football, and one which should make the College of Engineering quite proud, is that twelve of this year's lettermen push sliderules when not performing on the gridiron. Those who speak of "snap" courses for athletes and think of football players as scholastic duds would be in for a mild shock could they but view present and past records compiled by the players enrolled in some of the toughest courses at Cornell.

The two regulars who made Dean's List this year, Charlie Metzler, starting left tackle from New York City, and Don Follett, defensive guard from Long Island, are both mechanical engineers. Charlie, incidentally, has the highest cumulative average on the team with his 87.29 for three years. Another man whose studies match his excellent defensive play is linebacker John Dorrance. John, also a mechanical engineer, has a three year cumulative average of 83.68.

Other engineers on the squad are Clarence Fauntleyroy, Charles Fratt, Bill George, Dick Hagenauer, Lindy Hull, Walt Knauss, Al Pyott, Tom Duff, and Reggie Marchant.

Synthetic Gravel

A two man team from Cornell University has reported the development of a process for producing synthetic gravel from mud. The process was developed by Prof. Benjamin K. Hough of the School of Civil Engineering and Prof. Julian C. Smith of the School of Chemical and Metallurgical Engineering, during a study of soil properties and stabilization.

They said the technique holds promise for solving a number of special problems in road building and other construction, particularly at locations where gravel is scarce or non-existent.

The synthetic gravel is made from mud, inexpensive chemicals, and sulfite liquor, a waste product from the paper industry. In tests, individual pieces have been submerged in water for six months without disintegrating. They have withstood freezing and thawing and drops from a three-story height.

The chief ingredient, waste sulfite liquor, has been used for years for laying dust and for temporary stabilization of muddy roads and highway shoulders, but its value has been limited by its solubility in water. The Cornell investigators found that the problem could be solved by what they have named the "Chrome-Lignin soil solidification process."

This is based on a well known reaction of the sulfite liquor and a chromium compound which together form a stiff water-insoluble jelly. Addition of the jellying chemicals gives soils considerable cohesive strength and makes them almost impervious to water. Experiments showed that the binder is effective with a wide variety of soils, ranging from beach sands to heavy clays, and is not affected by organic contamination in the soil.

The research workers estimate that a truckload of chemicals can produce some thirty truckloads of artificial gravel. They emphasized that the product probably could not complete with natural gravel, but pointed out that there are numerous areas in the United States and other counteries where natural gravel is non-existent.

An additional value of this process stems from the fact that the disposal of the sulfite liquor presents a large problem to the pulp producers. Three million tons or more go to waste each year, much of it into streams where it is a leading cause of water pollution.

Coop Society

Probably one of the most worthwhile, but little publicized engineering groups on campus, is the cooperative society Mu Sigma Tau.

Mu Sigma Tau was set up to familiarize students with the cooperative program by giving them the chance as sophomores to meet and hear men from companies affiliated with the plan. Once they have begun their cooperative work, Mu Sigma Tau tries to help these students along by aiding them in securing rooms and getting settled wherever they are working.

One of the few organizations here on campus during the summer, Mu Sigma Tau has many social func-

(*Continued on page* 32)

Professors Hough and Smith examine some newly-produced gravel that had been made from mud.

—Photoscience

CORNELL SOCIETY OF ENGINEERS

107 EAST 48TH STREET 1951-52 NEW YORK 17, N. Y.

FREDERIC C. WOOD, C.E. '24, *President* ....27 Overlook Drive, Greenwich, Conn.

KARL J. NELSON, *Executive Vice-President* ....321 North Ave. E., Cranford, N. J.

PAUL O. REYNEAU, M.E. '13, ...*Secretary-Treasurer and Representative, Cornell University Placement Service,* 107 East 48th Stret, New York 17, N. Y.

WALTER M. BACON, E.E. '30, *Recording Sec'y.* 510 East 84th St., New York 28, N. Y.

Syracuse Branch
WILLIAM F. ZIMMERMAN, M.E. '16, *Vice Pres.* 103 Archer Road, Syracuse, N. Y.

Philadelphia Branch
THOMAS W. HOPPER, M.E. '29, *Vice President* ....1700 Sansom St., Phila. 3, Pa.

New Jersey Branch
JOHN WEIKERT, *Vice President* ....9A Parkway Village, Cranford, N. J.

Detroit Branch
PHILIP J. KENT, M.E. '15, *Vice President* ....................P.O. Box 1919, Detroit 31, Mich.

Chicago Branch
THOMAS S. McEWAN, M.E. '11, *Vice President* 1046 Dinsmore Road, Winnetka, Ill.

St. Louis Branch
SHURLY R. IRISH, M.E. '19, *Vice Pres.* ....306 South Gore Ave., Webster Groves, Mo.

Honorary President: S. C. Hollister, Dean of the College of Engineering

Honorary Vice Presidents:
C. R. Burrows, Director of the School of Electrical Engineering
N. A. Christensen, Director of the School of Civil Engineering
H .J. Loberg, Director of the Sibley School of Mechanical Engineering
F. H. Rhodes, Director of the School of Chemical and Metallurgical Engineering
W. R. Sears, Director of the Graduate School of Aeronautical Engineering
L. P. Smith, Director of the Department of Engineering Physics

Frederic C. Wood

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish closer relationship between the college and the alumni."

The Organization meeting of the Boston Section of the Cornell Society of Engineers was held on December 5. The people up there did a grand job of organizing it, too. There were about seventy men for dinner. Officers were elected and committees appointed. Creed Fulton, Chairman of our Committee on Regional Sections, and I were there. We were to be the back scenery in the show and Dean Hollister was to be the main speaker, but bad weather grounded Hollie's plane and he didn't make it. Creed and I put on a substitute performance to the best of our ability, but I am afraid it was a bit corny. Everyone seemed to have a good time, however, but that was due to the Boston crowd's acceptance of the situation with such a good sense of humor.

The New York group has had two fine meetings so far this year. At the first, Professor Orval French introduced most of us to a new subject—agricultural engineering. It has a bright future, and though now in the College of Agriculture, may eventually be an Engineering College course.

At our second meeting, Carleton Ward, one of the University trustees who is on the committee which is making a special study of engineering at Cornell, told us a great deal about Cornell, about engineering, and engineering at Cornell. Anyone who missed hearing Carleton Ward talk missed a chance to hear some-interesting and inspirational things about our Alma Mater.

On the 17th of January I looked forward to attending a "Cornell Engineering College Night" which the Philadelphia Section was holding. Headmasters and Principals of schools in the Philadelphia area were special guests. This sounded like a great way of selling Engineering education—and especially Cornell. Dean Hollister was the main speaker and no one knows the subject better than he does.

FREDERIC C. WOOD

ALUMNI NEWS

John W. Holt, M.E. '08, of Salisbury, Connecticut, has retired "we hope. Several previous attempts ended in failure," he writes.

Robert W. Clark, C.E. '09, is the city engineer and director of public works at Meriden, Connecticut.

Edwin S. Crosby, M.E. '10, has retired from the Presidency of Johns-Manville International Corporation.

In college, Mr. Crosby's spectacular contributions to the basketball team, which he captained, and to the football team, were never permitted to interfere with his study activities in Sibley. As a result he was one of the first ones sought after by industry. He began his career with the Wisconsin Steel Company and was sent to France during World War I as a Captain in Ordnance to help set up plants for the AEF.

After his return to the States in 1919, he joined the Celanite Products Company, which was eventually taken over by Johns-Manville. Mr. Crosby remained with the Johns-Manville Company until his retirement, most of the time as president and director of the subsidiary through which it carried on the manufacture of asbestos products in foreign countries.

Mr. Crosby lives with his wife at 7 Washington Park, Maplewood, New Jersey.

Thomas H. McKaig, B. Arch. '11, C.E. '13, consulting engineer with offices at 881 Main Street, Buffalo, has opened a branch office in Forest Home, Ithaca. His staff in Buffalo includes **Warren H. Wohlers, '27, John R. McKaig, '30, George M. Rupley '42, Robert G. Holzman '44** and **Norman F. Kirchner '50.** McGaig is the author of "Applied Structural Design" and is a contributing editor to "The Empire State Architect."

Alfred L. Boegehold, M.E. '15, was named assistant to the General Manager of the General Motors Research Laboratories. He had previously been head of the GM Research Metallurgy Department, a position he has held since 1935. He lives with his wife at 18414 Muirland, Detroit, Michigan.

Henry M. Reed, Jr., M.E. '28, is vice-president and general manager of manufacturing at the Louisville (Ky.) works of the American Radiator & Standard Sanitary Corporation. His brother, John C. Reed IV, is vice-president of research at the Tiffin, Ohio plant of the firm.

Andrew J. McConnell, E.E. '28, was recently named chairman of the Committee on Relays for 1951-52 by the American Institute of Electrical Engineers. He is an application engineer with General Electric Co. in Schenectady.

James P. Tattersfield, M.E. '30 is manager of Babcock and Wilcox Company in Mexico, Central America, and Northern South America.

Alfred L. Boegehold

Lieutenant Colonel Haywood G. Dewey, C. E. '35, who was recalled to active duty in August, 1950, is now executive officer of the 32nd Engineer Construction Group in Korea. Mrs. Dewey and their three children live at 1201 East Center Street, Anaheim, Cal.

In recent ceremonies at San Diego, California, **Commander Hugh Wyman Howard, USN, M.S. ChemE. '45,** Naval Academy '37, was awarded the Bronze Star with Combat Distinguishing Device. The presentation was made in the name of the President of the United States by Rear Admiral John W. Roper.

Commander Howard's citation was awarded for meritorious service in Korean operation as Commanding Officer of the Destroyer Hollister, which included the Formosa Neutrality Patrol, Inchon invasion, and the evacuation of Hungnam.

Since his graduation in 1945, Commander Howard has served as Gunnery and Air Defense Officer of the Battleship Indiana, and as Gunnery and Readiness Officer on the Staff of Vice Admiral Arthur D. Struble, until recently the naval commander of the Seventh Fleet in Korean waters. He was appointed in 1949 as a member of the Management Survey for the Office of Under Secretary of the Navy and Chief of Naval Operations. In September 1950 he took command of the Hollister in Far Eastern waters.

Paul H. Kirchner, B.E.E. '50, married **Doris Paine, Home Ec '51,** in Woodbury, N. J., on October 13. Recalled from the Army Reserves to active duty last March, Kirchner expects, after his release from active duty in November, to continue working for the Signal Corps Engineering Laboratories, Fort Monmouth, N. J., as a civilian electronics engineer in the Frequency Control Branch, where he was assigned while in the Army.

CORNELL UNIVERSITY

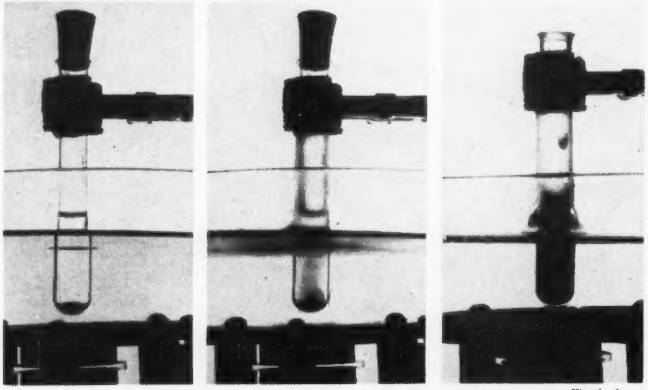
SCHOOL OF MECHANICAL ENGINEERING

CLASS OF 1952

1. Frisch, R. A.
2. Swift, W. V.
3. Potter, E. C.
4. Gill, T. B., Jr.
5. Dalton, W. K.
6. Multer, H. C.
7. Waight, W. J.
8. Schreiner, D. A.
9. Acker, J. W.
10. Loberg, H. J. (Director)
11. Hamilton, W. R., Jr.
12. Patton, J. M.
13. Ferguson, W. H.
14. Sager, R. B.
15. McGarigal, J. J.
16. DeLorenzo, W. A.
17. DeSanctis, A. M.
18. Jansen, K. L.
19. Loveland, J. S.
20. Rogers, S. E.
21. Dixit, P. M.
22. Rogers, J. T.
23. Geohegan, J. T.
24. Brancaccio, J.
25. Howell, J. K.
26. Weber, E. C.
27. Salditt, F. P.
28. Morlath, R. C.
29. Nelson, H. F., Jr.
30. Germond, H. S., IV
31. Orr, J. D.
32. Stein, G. L.
33. Eigo, J. W.
34. Spencer, P. D.
35. Swanson, D. L.
36. Stahr, R. S.
37. Petrulis, F. C.
38. Beer, A. C.
39. Griffin, D. S.
40. Wright, J. T.
41. Siegfried, R. H., Jr.
42. Nulsen, E. C.
43. Payne, R. R., Jr.
44. Nickles, J. E.
45. Edlund, T. W.
46. Auleta, J. J., Jr.
47. Jensen, H. E.
48. Marble, R. W.
49. Jensen, R. D.
50. Blake, T. B.
51. Moore, C. H., Jr.
52. Knapp, F. E.
53. Whitehouse, J. R., Jr.
54. Kiplinger, D. G.
55. Clegg, J. B.
56. Vinson, J. R.
57. Street, R. L.
58. DiGrande, V.
59. Hull, L. C.
60. Ehret, J. B.
61. Phifer, J. C.
62. Baum, J. R.
63. Sacra, G. H.
64. Phillips, R. A.
65. Reade, R. S., Jr.
66. Coene, E. T., Jr.
67. Ingersoll, H. H., Jr.
68. Mazzarella, M. J.
69. Ames, R. E.
70. Coykendall, R. E.
71. Cohoe, D. L.
72. Gottling, P. F., Jr.
73. McCulloch, E. H., Jr.
74. Staunton, J. E.
75. Ferrari, A. S.
76. DeCarlo, F. X.
77. Votapka, O. E.
78. Laaksonen, L. E.
79. Rose, P. H.
80. Sutton, G. W.
81. Johnson, O. D.
82. Jaggard, A. M.
83. Parker, M. S.
84. Broida, I. S.
85. Mishler, H. W.
86. Southworth, E. F.
87. Jackson, R. C.
88. Messina, W. A.
89. Ayers, I. M., Jr.
90. Wasserman, A. L., Jr.
91. Burrough, L. R., Jr.
92. Shand, R. P.
93. Reynolds, R. W.
94. Rindge, F., Jr.
95. Pfretzschner, C. A.
96. Green, E. F.
97. Britton, W. E.
98. Nick, W. M.
99. Luce, L. E., Jr.
100. Browning, L. L., Jr.
101. Bressler, M. N.
102. Klingenberg, A. D.
103. Sporck, C. E.
104. Perry, G. E.
105. Burckmyer, L. L.
106. Kinne, G. C.
107. Herzstein, S. E., Jr.
108. Siff, E. J.
109. Acker, F. D.

Into your home, through the miracle of television, comes a new world of entertainment, news, education, and sports.

TECHNIBRIEFS



—Westinghouse

—Westinghouse

Above: Steps in the emulsification of mercury and water using high frequency sound waves. Right: the ultrasonic generator.

UHF Sound Waves

High frequency sound waves are proving to be a useful tool for research and industry. Scientists find them useful for mixing such naturally insoluble substances as oil and water, or mercury and water. Industrialists find them useful for non-destructive testing of metal castings and concrete structures, as well as for mixing paint pigments. They also see a bright future in ultrasonics for improving clothes washers, for agglomerating smoke particles, for pasturizing milk, for sterilizing containers, and for many other uses.

The Westinghouse Research Laboratories are now making a study of the fundamental properties of these waves, the source of which is an ultrasonic generator. A jar of oil atop the generator contains the heart of the device—a tiny quartz crystal. The application of a high generated voltage across the crystal causes it to vibrate hundreds of thousands of times a second—about 750 thousand. These vibrations create ultrasonic waves; the ultrasonic waves agitate the molecules in the liquid and, if continued long enough, complete mixing or emulsification takes place.

In the illustration the test tube is filled with water and mercury and immersed in the oil-filled jar a few inches from the crystal. In the left-hand photo, the reaction has just gotten under way—the globule of mercury is visible in the bottom of the tube. As the impact of the sound waves takes effect, a cloud of minute particles of mercury forms in the water. Complete mixing or emulsification of the two liquids is achieved in the right-hand photo. Internal pressure blew the cork out of the test tube.

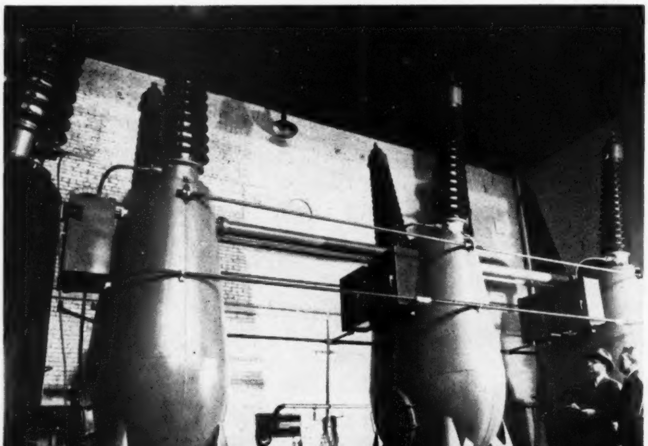
New Breakers

Giant oil-filled circuit-breakers (see photo) now are streamlined to conserve oil and manpower. The new "watch-case" design, which conforms to the working parts of the breaker, results in a 50 per cent saving in the amount of insulating oil required as compared to the conventional drum-shaped tank. Since the oil must be filtered periodically

(*Continued on page* 40)

These queer shaped objects are giant oil-filled circuit breakers, employing the new and more economical "watch-case" design.

—Westinghouse

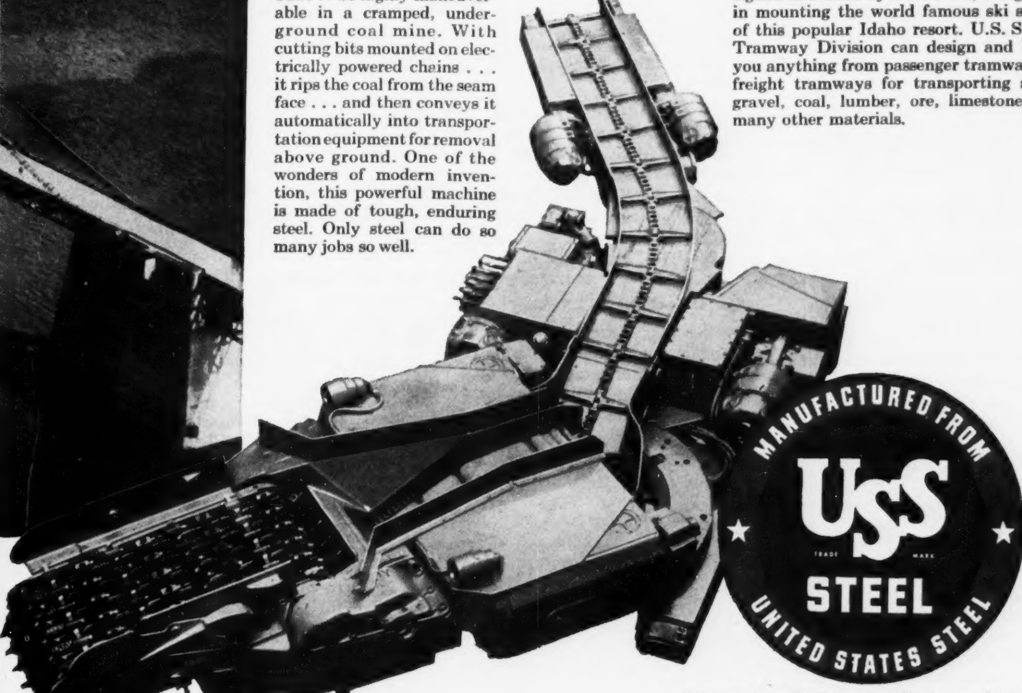


so well

FLOODWALL OF STEEL. 76 earth-filled cells like this, built of interlocking U·S·S Steel Sheet Piling, protect a Kentucky rolling mill against flood waters in the Ohio River Basin. Because of its great strength, long life, and low installation cost, this product of U. S. Steel is invaluable in all types of projects involving control of earth and water.

EASY WAY UP FOR A FAST TRIP DOWN. Skiers at Sun Valley find this "chairway" designed and built by U.S. Steel, a big help in mounting the world famous ski slopes of this popular Idaho resort. U.S. Steel's Tramway Division can design and build you anything from passenger tramways to freight tramways for transporting sand, gravel, coal, lumber, ore, limestone and many other materials.

STORY-BOOK DRAGON? No, this is a continuous miner, built to be highly maneuverable in a cramped, underground coal mine. With cutting bits mounted on electrically powered chains . . . it rips the coal from the seam face . . . and then conveys it automatically into transportation equipment for removal above ground. One of the wonders of modern invention, this powerful machine is made of tough, enduring steel. Only steel can do so many jobs so well.



This trade-mark is your guide to quality steel

Listen to . . . The Theatre Guild on the Air, presented every Sunday evening by United States Steel. National Broadcasting Company, coast-to-coast network. Consult your newspaper for time and station.

UNITED STATES STEEL *Helping to Build a Better America*

AMERICAN BRIDGE . . AMERICAN STEEL & WIRE *and* CYCLONE FENCE . . COLUMBIA-GENEVA STEEL . . CONSOLIDATED WESTERN STEEL . . GERRARD STEEL STRAPPING . . NATIONAL TUBE
OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* **UNITED STATES STEEL COMPANY, PITTSBURGH**
GUNNISON HOMES, INC. · UNION SUPPLY COMPANY · UNITED STATES STEEL EXPORT COMPANY · UNIVERSAL ATLAS CEMENT COMPANY

EDITORIALS

In attempts to produce a "new kind" of engineer, Harvard and Columbia Universities have announced new plans for greatly expanding the size and scope of their engineering schools.

Both universities feel the pressing need of modern society for highly trained technical men who are both versatile engineers and capable leaders in industrial and civic affairs. Both will set up advanced work in subjects still to be thoroughly studied, and will try to staff their departments with the world's leading scientists and engineers. The students' training will be supplemented by contact with the other, more humanistic divisions of the universities. Columbia will set up augmented graduate and undergraduate programs, while Harvard will work only with graduate students.

Everyone recognizes the need for technically trained, but nonetheless educated men. President Killian of M.I.T., at his inaugural, said that some of the most technical courses given there should be deferred until a fifth (graduate) year, while the undergraduate should have more of the humanities. M.I.T. now requires four one-year sequences in the humanities. Cornell's five-year program shows signs of this recognition. And other universities also have considered the problem, although there are very few five-year curricula in this country.

The Universities' Plans

Columbia's ideas are these: the university will ultimately have 750 undergraduates, and 1000 graduate students in engineering. It will train an engineer who has a statesmanlike point of view and who is a truly rounded person with a broad knowledge of the world around him. The emphasis will be on the engineer-scientist who, with his scientific training, will bring about better analyses of the world's events and problems.

Harvard's plans are embodied in these paragraphs:

> The object should be to train men who will become leaders in university, industry, or government, operating successfully in a society rendered complex by science, by reason of their sound grasp of scientific subjects, their ability to apply these well, their understanding of the framework of society within which the application will be made, and their worth as educated men.
>
> . . . . undergraduate instruction in engineering sciences and applied physics will be continued as in the past, and the developing program for graduate students training for professional careers in engineering and industry will be limited to a small, select student body.

Some details have been omitted here, along with great quantities of self-congratulation on the part of the universities for their past achievements. With these achievements no one can quarrel, but we can dispute the wisdom of some parts of the plans.

Some Objections

In the first place, it seems unreasonable to suppose that students who enter graduate school in engineering are especially desirous of professional and civic leadership. There seems implicit the assumption that the engineer-scientist will also be the guiding light in extra-technical matters. There are juxtaposed the ideas of high-powered research and training for leadership. This is unreasonable, for the more intense the researcher, the less likely will be his drive toward leadership. And graduate school is no place to instil the desire to lead; the majority never reach it. It is well to remember that the smaller the student body the greater is the likelihood of good coming about by chance. This brings us to a second objection.

There is no need to confine this kind of training to graduates only. More undergraduates can profit by better thought-out and administered curricula than are now doing so. It is evident that the aristocratic scheme proposed by Harvard will not furnish enough versatile engineers or administrators, let alone enough of each. Undergraduates must know their society too, and all the aspects of its complicated culture. The more they are made aware of civilization the more satisfactorily they will perform both their engineering and extra-engineering jobs.

Cornell's Curriculum

Let us examine Cornell's curriculum to see how it can approach the worthy goals of Harvard and Columbia on an undergraduate level.

First, their goals are ours; the five-year curriculum was to set up to produce better and more rounded engineers. Revisions and examinations are always in order, however.

In the matter of electives—necessary instruments in affording flexibility and perspective—undergraduates are granted total credits amounting to about one in ten, certainly a very small allowance. There are in addition such discrepancies in policy that the EE's may be urged by their professors to take courses in music, while ChemE's are denied credit for any course in the subject. The EE school is notable in particular for urging the taking of non-technical electives and is now considering the possibility of reducing the total technical load to make room for electives. The EP's also benefit by being allowed more non-technical electives.

Where the opportunity for electives now exist, the scheduling of required courses often makes impossible the scheduling of desired objectives. Little is done to alleviate this situation, but here lies a major device for making more flexible curricula.

Faults of Some Courses

Special courses for engineers such as psychology and economics are

(Continued on page 44)

COLLEGE NEWS

(*Continued from page* 21)

tions for summer session engineers including trips to Taughannock Falls and other local places of interest. This year will see the installation of new chapters in Rensselaer Poly Tech., M.I.T. and Drexel. On the lighter side, they have also scheduled numerous beer parties and discussion meetings for the coming year.

AIChE Meetings

Among the interesting speakers which A.I.Ch.E. has had at their meetings recently are Dr. Harold L. Smith from Eastman Kodak Co. and George H. Bancroft from Distillation Products Inc., a division of Eastman Kodak. Dr. Smith, who spoke on December 14, discussed extensive work he had done on Gel Lacquers. Mr. Bancroft gave an illustrated lecture on the industrial uses of high vacuum.

Among its other projects, A.I.Ch.E. is planning a series of displays for the Olin Hall Library. The displays, which are to be changed every two months, will be on various phases of the chemical industry.

Tau Beta Pi Tutors

This year Tau Beta Pi, general engineering honorary, has undertaken a tutoring service for freshmen engineering students who are doing poorly in their studies. Tutoring is given without charge by members of the society, many of whom are instructors in freshmen courses.

Metals Society Dinner

Statler Hall was the scene of a dinner in observance of the silver anniversary of the Southern Tier Chapter of the American Society for Metals.

William H. Eisenman, executive secretary of the society presented the chapter with a certificate of commendation. Walter E. Jominy, staff engineer of the Chrysler Corporation and a former president of the society, spoke on "Applications of Hardenability."

CRANES

(*Continued from page* 12)

center of the luffing stroke with a gradual slowing down to a dead stop at each end of the stroke. This kind of movement, which closely approaches simple harmonic motion, is the ideal luffing motion for a crane.

Because of the level luffing feature, present-day cranes of that type can be operated at a very fast pace. The boom can be luffed from maximum reach in 12 seconds instead of 45 to 60 seconds required with an ordinary boom. Furthermore, since the operator need not be concerned so much with the luffing he can perform the swing and hoist motions much more rapidly, and with greater safety. Level luffing cranes are used extensively in Europe for handling crude material and for loading cargo ships. A battery of 8 modern 6-ton level luffing wharf cranes is used at Bordeaux, France. The opposition of stevedores and the

(*Continued on page* 34)

Cranes

(*Continued from page* 32)

apathy of American owners has kept this type of crane in the background here; only one such crane is known to be in operation in this country.

Floating Cranes

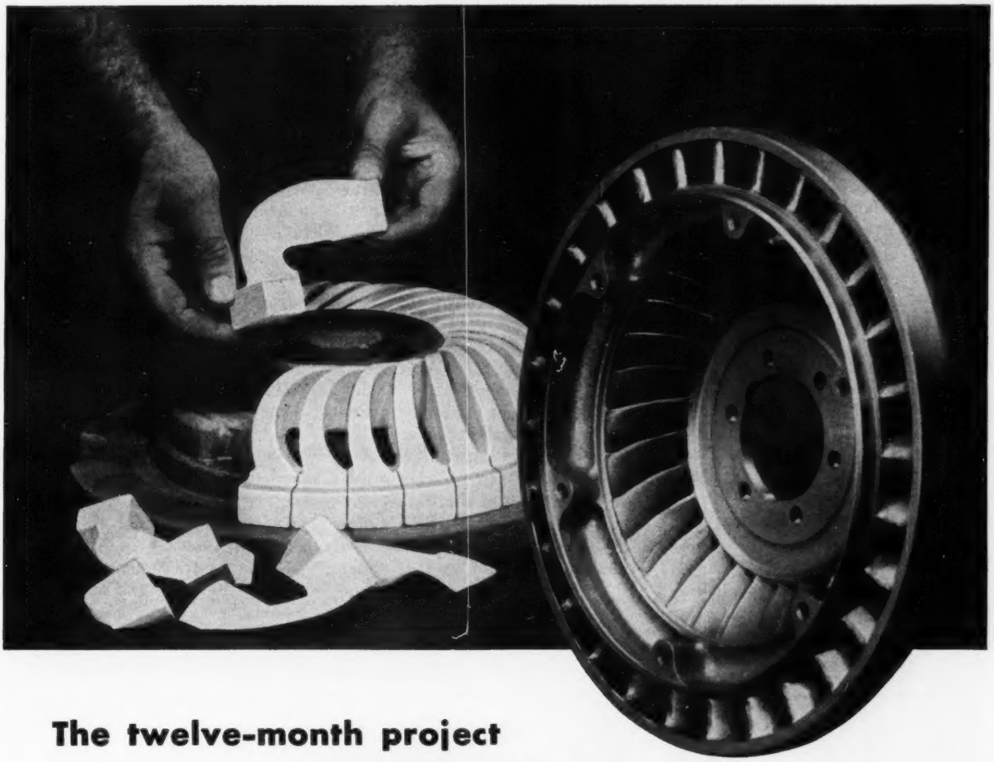
Floating cranes are usually used for ship fitting out and ship repair service. They are actually special ships, and can move about easily anywhere in a bay wherever a ship may go, or they can go alongside waterfront structures. No tracks are needed, so they may be very large yet quite mobile. The absence of all running ropes greatly increases their general utility. A floating crane can be moved a thousand miles, if necessary, and be ready to work when it gets there. Most floating cranes are moved by tugs, although for small movements alongside a ship or pier, winches on their deck may be employed. These cranes are designed structurely and mechanically to stand lateral loads caused by listing and the heavy lateral loads caused by rolling at sea.

Modern Industrial Cranes

Present-day cranes are adaptable to almost every type of weight-lifting needed in modern industry. Equipped with clam-shell buckets, they are used for loading, unloading, storing and rehandling all sorts of loose material into bins or piles. In bucket work they are used in excavating for abutments, piers, foundations and sewers, and for back filling, ditching, and grading. Equipped with magnets, cranes are used for loading, unloading, and rehandling tieplates, splices, bolts, nails, spikes and the many forms of iron and steel bar, steel car wheels, and iron and steel scrap in various forms.

With hook and block, modern cranes are used for loading, unloading, and rehandling such bulk materials as large granite and stone blocks, cast iron and concrete pipe, timbers, wheels and axles, trucks and steel rails. They are also used for the laying and shifting of rails and erection of steel structural trusses and heavy girders. With dragline bucket, they are used in

(*Continued on page* 36)



Cranes

(*Continued from page* 34)

dredging, ditching, surface excavating and underwater excavating. When equipped with a pile-driving attachments, they are used for driving wood, steel and concrete piles, and for pulling piles. Also with steam shovel attachment, they are used for trimming high banks, ditching, digging, excavating, and making roadways. A modern wrecking crane can lift an entire coach or tank car from the rails when necessary. In factories, cranes move large, heavy sub-assemblies into place with maximum speed and accuracy. With their great strength of design and their smooth, reliable, positive action clutches, the cranes of today can be designed for practically every weight-lifting requirement of modern industry.

World's Largest Crane

This huge structure is capable of lifting 450 tons. It is used in repairing major fleet units of the U.S. Navy; it can lift an entire battleship turret at one time. Actually, this machine consists of twin bridge cranes, mounted on twin runways 730 feet long. The pier on which it stands was specially built to accommodate it. The two bridge cranes operate separately on the runway, and can each lift 240 tons. The equalizer beam between them and the hook it carries weighs 40 tons.

This powerful crane is operated from cabs located at one end of each bridge crane structure, giving maximum visibility of the crane's hook regardless of the postition of the trolley. Lifting, derricking, slewing and traveling are controlled from the cabs. The two crane operators each use walkie-talkie outfits to communicate with an observer on the ground. The traveling gantries and trolleys of this crane were made by Alliance Machine Company, Ashland, Ohio, and the American Bridge Company built the runway. At the present time this crane is the largest one in the world, but in a few years an even larger, more powerful one will be built to service the new giant Navy carriers now under construction.

The use of cranes is of great antiquity, but since the vast industrial development of the 19th century the crane has acquired an important and indispensable position in the economy of all nations. Whenever finished goods such as machines, buildings, and ships are made and used today, cranes of various forms will be found in use. Only a few generations ago the wharfs of America bristled with the masts of ships loading and unloading their cargoes. Today, the huge cranes that line our costal piers overshadow the ships so greatly that many of the ships seem almost to be toys by comparison. It is not too much to say that the modern crane, despite its drab and ungainly appearance and its lack of appreciation by the average citizen, has been an important keystone in America's development for the past 100 years and will continue to play an indispensable role in the future industrial growth of this country.

Printed Circuits

(*Continued from page* 17)

points where it passes through the stencil.

Chemical Deposition

Because the chemical methods of depositing conductive and resistive materials on insulators are in general more complicated and expensive, they are not widely used, but are worthy of mention. One of the principle methods employed is in forming a solution of ammonia, silver nitrate and a suitable reducing agent. The mixture is then applied through a stencil to the base plates; silver precipitates along the circuit configuration. One novel chemical process consists of using different colored metals for the different stages of the circuit, thus facilitating identification and classification of the various circuit sections.

Vacuum Processes

Printed circuits made by these processes are usually limited in size due to the necessity of keeping the base plate in a vacuum while the printing takes place. In the cathode sputtering process, the metal to be volatilized is made the cathode and the work is the anode. A high voltage is applied between them and metal emitted from the cathode is attracted to the plate and deposited through a stencil. In the evaporation process, no potential is applied —the metal is merely evaporated and deposits on the base plate. It is usual to employ several runs in the vacuum processes in order that a conductor of sufficient thickness is formed.

Die-Stamping and Dusting

It has been found that in the production of certain types of electronic sub-assemblies it is advantageous to pre-form connecting wires and component leads by die-stamping them from sheet copper. Blank spaces in the thin conductor provides for additional of the circuit elements. One particular application of this process is in the production of loop antennas from single pieces of sheet copper for table model radios.

By applying an initial binder along the circuit configuration, dusting a metallic powder over this and firing to a sufficient temperature, a printed circuit is obtained that is somewhat similar to that achieved by painting methods. Research into the possibility of utilizing electrophotographic methods to reproduce circuits by powdering is being carried on.

Following the application of circuit conductors and elements by the methods outlined above, external connections are soldered directly to the silver or to eyelets on which the wiring terminates. The entire assembly is then given a durable protective coating to resist abrasion, humidity, etc. Thus, the finished assembly takes the form of a single small disc-like part although in reality it may be a complete amplifier or coupling stage.

Performance

It can be generally said that performance of printed electrical circuits is comparable and in some cases exceeds that of conventionally wired electronic circuits. It is pos-

(*Continued on page* 40)

Printed Circuits

(*Continued from page 38*)

sible to control conductor resistance and provide for adequate current carrying capacity merely by controlling the paint components and thickness of printed conductors. Power dissipation of resistors is in most cases quite adequate. It was found that printed resistors have the desirable property of introducing infinite resistance in the circuit when seriously overloaded, thus blocking overload in following circuit components. Conventional resistors of comparable rating practically short circuit under the same conditions of overload. Resistor paint formulation may be controlled to provide excellent temperature characteristics and resistors generally may be manufactured to ± 15 percent tolerance with no added expense. Performance of printed capacitors and inductors is almost identical to that of conventional elements and tolerances of ± 10 percent are common in mass produced circuits.

A large variety of subminiature tubes are available for use with these printed circuits. They can be plugged directly to the base plate, thus providing the ultimate in compactness and simplicity. Recent developments include printing of a complete amplifier circuit directly on the envelope of a 6J6 twin-triode tube.

Applications

Printed electrical circuits are being used in thousands of different applications—amplifiers and subassemblies, hearing aids, transmitters and receivers, and many others. Printed plug-in subassemblies are now in use—this means that principal units of electronic instruments can now be tested individually and replaced by merely plugging in a new unit.

The field of printed electrical circuits is expanding rapidly and with new technological developments it is highly possible that John Q. Public will someday wear a radio transceiver on his wrist much as he now wears a wristwatch.

Technibriefs

(*Continued from page 26*)

to remove carbon deposits and moisture, the oil saving also results in a saving of manpower. First of the "watch-case" breakers was recently shipped to the Bonneville Power Administration. The new design will be a feature of future breakers rated at 230 kva and above.

Sun Motor

Power from nature's greatest energy reservoir, the sun, can be tapped by a new device now being demonstrated by General Motors.

Known unofficially as a Sun Motor, this mechanism illustrates how sun-light can be converted into enough electrical energy to spin a balsa wood wheel on the shaft of a small motor. If sunlight isn't available, heat of a candle, or light from a 150-watt lamp does the job.

General Motors engineers admit that the Sun Motor is an extremely low efficiency device, and was built only to demonstrate that sun-light is energy. How to harness this energy for such everyday chores as heating homes, running electrical appliances, or even propelling vehicles is a problem many engineers and scientists are thinking about.

Scientists agree the sun wastes its energy lavishly. They point out that enough sunshine drenches the roof of an average one-family dwelling in 30 minutes to light, heat, and run the electrical appliances in that dwelling for an entire year.

The Sun Motor offers no clues to the secret of the sun's vast energy storehouse. In its inefficient way it merely points out that energy from sunlight is available, if it can be put to work efficiently.

Carbide Coating

The possibility of being able to coat metal parts with a relatively thin skin of ultra-hard, wear resisting, tungsten carbide was forecast recently by the General Electric Company.

The Company announced that it had completed basic laboratory development on a "weldable" tungsten carbide. It can be flowed onto metal surfaces, using conventional shielded electric arc welding equip-

(*Continued on page 42*)

Technibriefs

(*Continued from page* 40)

ment, available today in most of the larger and even many smaller metal working plants.

When flowed on to a metallic surface such as steel or iron, it fuses and blends with the base metal and results in a surface coating containing approximately 70% of wear-resisting tungsten carbide.

Wear tests conducted so far indicate that such a surface has a wear-resisting ability of approximately 80% more than that of "undiluted" tungsten carbide — and about 15 to 20 times that of the best chilled cast irons of 43 to 67 Rockwell. Data on the latter comparison were obtained using an aluminum oxide dry abrasion test.

The process of skin coating (1/16" to 1/4" thick skin) appears to be most suitable where it is desired to wear-proof parts for which the use of solid carbide sections is inconvenient.

Although most suitable where high surface finish of the coating is not essential, a surface coated with tungsten carbide in this manner can be ground or polished using conventional equipment as for solid tungsten carbide parts.

Cathode Rays Sterilize

Blood plasma, for the treatment of military casualties as well as civilians, may be sterilized with high-energy cathode rays more efficiently than with methods now employed, General Electric reports.

The great advantage of cathode rays in killing germs and molds, is that such sterilization may be accomplished without heating the material. This is particularly attractive for certain drugs, and other products that might be damaged by heating.

The application of high-energy electrons in the field of food sterilization also has far-reaching potentialities. In laboratory experiments, meat, fresh beans, grains, blueberries, strawberries, peaches, raisins, bread and honey have been sterilized in this way.

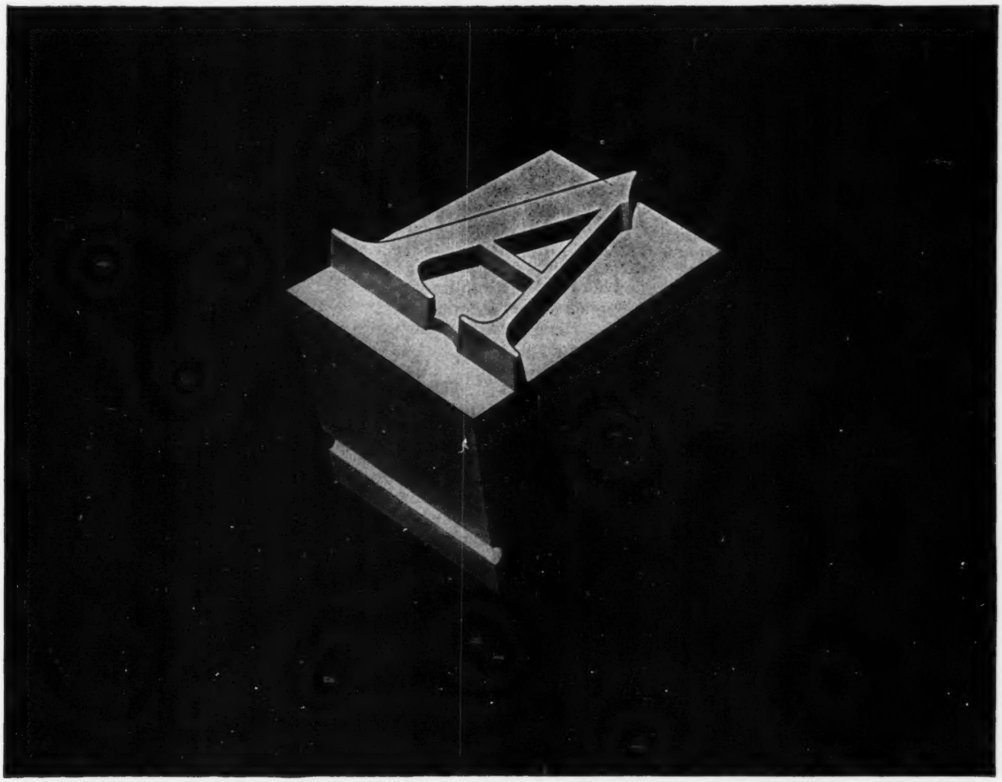
Wrapped bread that has been exposed to the cathode rays has been kept for many months at room temperature without becoming moldy and has retained a fresh bread odor. Even sterilization of the surface of some foodstuffs may have far-reaching implications. By extending, only for a few days, the time that perishable foodstuffs can be stored, or transported, without reduction in quality, the economics and utilization of these products can be vastly changed.

Plastic Blowers

Plastics have found another use in the electric motor field, and are now being used to replace critical aluminum and bronze for blowers in small, totally-enclosed, fan-cooled a-c motors. The plastic blowers consist of a polyester resin, reinforced with glass fibers. Glass fiber reinforcement has been found to be superior to organic fiber reinforcement because of increased resistance to chemical attack and increased strength per pound.

The plastic blower has many ad-

(*Continued on page* 46)



Editorials

(*Continued from page* 30)

often seriously deficient because of the intent of the professor to water down, or to narrow the course, because his students are engineers. These survey courses, if much strengthened, can help in expanding their students' knowledge, since the opportunity for taking their substantial equivalents in the Arts College is small. The History of Science course (primarily for engineers) is an exception, in that it provides information at a high level of interest and ability. It is a model for other courses with similar intentions. It ought to be given earlier than the usual fourth year so that engineers can have a firmer knowledge of their scientific heritage and may employ it for a longer time as undergraduates. There is a need here for some awakening, which might be supplied to students by a demonstration by the members of the faculty of an interest in affairs outside of Cornell and engineering.

Courses themselves are often faulty. They frequently overlap, duplicate, repeat, meander from one topic to another without any strong directional tendency. The quality of teaching can be considerably improved as a previous editorial pointed out. A well planned course can be made aimless, and a loose assembly of diverse topics may be made exciting, depending on the ability of the teacher.

Thus there is room for improvement, and the scene is not one of inactivity, for some work is being done here and there to improve the undergraduate engineering curriculum. Reexamination and improvement are imperative, for we are convinced that students are usually apathetic to non-engineering subjects because of unawareness of them, not hostility. When attention is paid to the replacement of this attitude with one more lively, the aim of Harvard and of Columbia—and of Cornell all the while—will be achieved in a manner yielding the most benefit. I.B.M.

Letters:

Dear Sir, you worthless cur:

Never in all my long and honorable life have I, a constant reader of your magazine, been so offended as by your article "Cowcatchers—Their History and Their Glory." I believe that you are guilty of undignified and sensationalistic writing and of trying to put a fast one over on your readers. You are obviously incompetent, and ought to turn your job over to someone who has some brains, ability and good taste. You can consider this my final communication to you. Hereafter you may cancel my subscription. Don't return any unused balance, as I consider that it has been morally tainted by the time it has been in your office.

JOHN J. BLARNEY, Chem.E. '98

The ENGINEER has almost the largest circulation of any magazine of its kind, but its readership is almost totally mute. Here in the lonely garret in Lincoln we wish someone would write us a letter, even like the fictional one we print above. It shows some active participation in the affairs of the magazine, at least, and desires to promote health and welfare. Is there a reader in the circulation list who has views on engineering, education, or matters in general who would like to stir up some discussion and interest? Let him speak, and these columns can become more significant mirrors of opinion. I.B.M.

NEXT

Technibriefs

(*Continued from page 42*)

vantages over the aluminum and bronze blowers it replaces. It is unaffected by the chemical agents that attack the metals. Hence, it is desirable on motors used in refineries, chemical plants, and process industries where corrosive atmospheres may be present.

The plastic blower is as much as one third lighter in weight than its metal counterparts. While this may be but a matter of a few ounces, the reduction of inertia where frequent, rapid reversals are required is worthwhile. Preliminary tests indicate that the plastic blower has better resistance to abrasion than its predecessors. These advantages are obtained without sacrifice in blower performance. The blower has successfully passed overspeed tests at four times normal speed.

New H-C Engine

The General Motors Research Laboratories recently announced its new "19XX" high compression engine to the nation's leading petroleum refiners. This V-8 engine with a twelve-to-one compression ratio, when mounted in a 1951 standard Cadillac chassis, registered 29 miles per gallon at thirty miles per hour, 27.6 m.p.g. at forty, and 20 m.p.g. at seventy. In similar tests, a 1951 Cadillac with the stock 7.5-to-1 compression ratio V-8 engine of the same size, but lower horsepower than the "19XX" engine, gave 19.8 m.p.g. at forty miles per hour. This engine is rated as one of the most efficient in the automobile industry today.

Difference in the performance of the two engines was attributed to:

1. Combination of an increased compression ratio and an improved Hydramatic transmission unit coupled with the "19XX" engine.
2. Fuel of a higher octane rating than is today available for commercial use.

The "19XX" engine plus the new transmissions and higher octane fuel could easily result in savings on fuel of thirty percent or more over present day fuel consumption.

Detergents II

(*Continued from page 14*)

pounds per square inch and temperatures in the neighborhood of 150 to 200°C are required for an economical conversion. At the completion of the reaction, the catalyst is removed from the charge in filter presses. If the composition of the resulting oil meets the control specifications, it is ready for splitting.

Fat Splitting—The Colgate-Emery process, referred to previously, is employed by Armour to split the fats into glycerol and fatty acids. Pressures of about 650 pounds per square inch gage and temperatures of about 245°C are used. Automatic controls regulate temperatures, pressures, and flow rates. The splitting column is 3 feet in diameter and 67 feet high, and is made of low-carbon steel.

The fats enter the column at the bottom through a sparge ring which breaks them up into tiny droplets so that large specific surfaces will

(*Continued on page 50*)

EMINENT CORNELLIANS

Ostrander Elms led a blighted life. From the time the little boy in knee pants learned the difference between up and down, his unfortunate existence was a succession of upsurges and downfalls. Throughout his life, his friends knew of his approach by listening for the lonely whistle of the winds past his angular features, or for the flapping of his clothes in the wintry breezes. The little man who now rests beneath a simple, sturdy little stone beside East Avenue was a friend to all and a friend of all, but he never knew the sensation of happiness.

Because of a series of misfortunes too long and characteristically monotonous to relate, he survived to enter Cornell with the class of 1880, and soon became the favorite. People deferred to him because of his superior manners, gait, and ineffectuality. Unpreturbed by the constantly raging elements about him, he stepped carefully over the friendly chipmunks he met to and from classes. Tameness, generosity, and fair play were of his essence; he never kicked a chipmunk without giving previous warning.

And yet, when he graduated still with his class in E.E., no one guessed that his end would be as spectacular as it was. He had made many friends among all the strata and classes of teachers, students, and unbruised chipmunks, and every one of them was glad to see him go. Such was the first Armistice Day.

Plunged into the worries and squabbles of the Outside World, he quickly showed his inherent qualities by successively progressing from hole to abyss to nadir. In all of these wanderings he remained the simple, unaffected sole that he was, never asking, never giving, certainly never receiving, but punting chipmunks with the same warning and geniality.

He tried door-to-door selling, but was a failure. He tried electrical engineering, but was no success. He tried politics and became a canvasser, but quit because the opposition party gained too many votes. Poor Ostrander Elms, stumbling along with his brief-case, dreamed of the day when he would make his big splash in the world, when he too could spread his wings and soar like the albatross.

He felt the surgings of greatness come up within him. He had his head in the clouds—yes, Ostrander Elms was getting there. Who could not have foreseen that this epitome of human greatness was to flash briefly across the heavens? Who did not believe that Elms was a man to fly in the face of convention, a man to bring his school glory, great honor, obscurity? Indeed, only an unmyopic sage could have seen all this.

So we enter his middle years, patiently plodding in his inspiring, yet blundering footsteps. And Elms takes a new turn. He branches out into the arts, literature, architecture, angling. He canoes across Beebe Lake, first white man to do so, and hurtles the vicious rapids of the Cayuga Inlet, and all the while to his proud Alma Mater brings credit, notice, derision.

But all this dissatisfied him. He yearned for something higher and mightier, and perhaps, even flighty.

It is, however, not of the petty quarrels that lesser men like him are involved in, not of the amazing quiet and stealth with which he got a wife, not even of his days on the chipmunk farm, or of his fight for vivisection, or the famous flight to Mexico, or of the dark and obscure poetry that emerged from the bowels of his later life, but of his untimely—and very characteristic—end. That we now speak.

For Elms became, by profession, a mountain-climber, scaling all the major peaks of New York State, and stringing trunk lines up each of them. A mountain-climber, who, with his trusty helper Willem van Rijn, at last arrived at almost the peak of his career.

Rijn and he stocked up on supplies, medicines, Confederate Flags, and other orological necessaries, and were scaling the east side of the mountain. But the going was slow, since his trembling made a secure grip difficult. And the old wheezing, picked up in the early college days while studying chipmunks in his well-heated dormitory room during the dead of Indian Summer, prevented his eyes from focusing long enough to enable him to see where he was going. But trusty Rijn led him on.

He wheezed and trembled up the mountain, when, near the summit, Rijn demanded for himself the honor of standing upon the highest crag. Poor Elms quivered a refusal, his trembling feet touching off minor rockslides. At length Rijn grew irate, threw down his tongs, and assaulted Ostrander Elms, E.E. '80. Our hero toppled to his feet, and tried to rise, but his friend-turned-turncoat, now baring the true color of his lining, did what we might have expected him to do, and acted in accord with the overwhelming trend of Elm's life, and launched him from a precipice, after which our hero never made one of his characteristically impermanent upsurges. Such was the end of Ostrander Elms.

Both searchers failed to find the body.

Struck down in that untimely hour, Ostrander Elms forever symbolizes the finest in electrical engineering, mountain climbing, upstate New York politics, wallpaper design, and like pursuits. His efforts will almost be a fitting monument to him. We can picture him now, punting chipmunks, dreaming of new mountains, new peaks, never foreseeing that catastrophe at the last moment of his life which was brought about by his trusted friend from Rotterdam.

Detergents II

(*Continued from page 46*)

be available for hydrolysis. The small fat globules rise through glycerol-rich aqueous solution or "sweet water" which collects at the bottom of the column. During their ascent, the globules become progressively warmer, and hydrolysis begins when they reach the fat phase. Heat is supplied by steam at 245°C which enters through sparge rings at the top and bottom of the column. Water enters at the top and is heated by direct contact with the hot fat. The finely dispersed water falls through the mixture of fats and fatty acids, effecting hydrolysis.

The acids from the splitter pass directly to a storage tank to await distillation.

Refining of Fatty Acids—The degree of distillation of the split fatty acids depends upon the specifications of the products desired. Three bubble-plate columns comprise the still system and these columns are designed for a low pressure drop. The three columns operate at constant pressure, the first column operating at 40 mm, and the second and third at 5 mm. The maximum base temperature of all three is 250°C. Most of the distillate from the first column is returned as reflux; the small amount withdrawn consists mainly of the acids in the lower boiling range. This cut, often called the "odor cut" contains unsaponifiables. The residue goes to the second column where a second cut is withdrawn. Similarly, the residue from this column is run down to the third column which is directly below it, and the third and last cut is taken. The residue is sent to the stearine pitch tank.

The still system can handle 3500 pounds of fatty acids feed per hour.

Nitrile Preparation—The ammoniation tower is a bubble-plate column. It is connected to a shell-and-tube condenser directly above it. This condenser provides reflux for the tower and preheats the entering fatty acids. The incoming fatty acids pass through the condenser tubes and enter the column at one of the lower plates. The reflux stream from the condenser enters the column at the top plate. It is here that the reaction with ammonia takes place along with some nitrile formation. The residue from the column is sent to a small pitch tower where all fatty acids and ammonium compounds are stripped out by the incoming ammonia and are carried back to the ammoniation tower. The residue of the pitch tower is marketed as nitrile pitch.

The product leaving the reaction tower through the reflux condenser is vapor form is composed of nitriles, fatty acids, and ammonia. After being reheated in a superheater, the mixture enters the converter, which is a shell-and-tube unit with an aluminum oxide catalyst packed in the tubes and Dowtherm circulating in the shell to provide the necessary heat for reaction. The entering mixture is mostly converted into nitriles, the vapor phase product analyzing less than 0.5% unconverted fatty acids, ammonia, and water.

The mixture leaves through the bottom of the converter and is sent to a small bubble-plate stripping column. Water and ammonia are removed from the crude nitriles. The ammonia is recovered and sent back to the ammonia system; the water is discarded. The crude nitriles are withdrawn from the bottom part of this stripper and are either sent to storage or to a vacuum fractionating still for further refinement.

Amine Preparation—As mentioned previously, hydrogenation vessels are used for the conversion of nitriles to amines. The catalyst is Raney nickel. A temperature of 150°C has been found best for the conversion with hydrogen vapor pressure of around 200 pounds per square inch. Yields of about 85% primary amine are realized under these conditions; the balance is composed of secondary and tertiary amines.

The amines are distilled from a pot still through a single column of two or three plates; the still merely

(*Continued on page 52*)

Detergents II

(Continued from page 50)

removes small amounts of secondary and tertiary amines present. After distillation, the amines are pumped to storage tanks.

Quaternary Ammonium Salt Preparation—At the present time these salts are being produced at Union Stock Yards in Chicago.

An ordinary steam-jacketed autoclave with height four times its diameter converts amines to quaternary ammonium compounds. It has internal cooling coils, and the necessary agitation is provided by a mechanical stirrer.

The plant has two of these reactors, each capable of holding 15,000 pounds of the finished product. The amount of time required to produce one batch varies with the salt being produced. As much as forty hours may be required, but the usual time is about twenty-four.

Aqueous caustic soda (50-60%), anhydrous liquid methyl chloride, and the alkyl amine are pumped through flow raters (rotameters) in stoichiometrical amounts into the autoclave along with some isopropyl alcohol. The pressure is gradually allowed to reach 50 pounds per square inch. The reaction is encouraged by heat supplied by the steam. The temperature is kept between 185 and 210°F. At the end of the reaction, the steam is turned off and the mixture is cooled. The isopropyl alcohol is a diluent.

The reaction products are then removed through the bottom of the autoclave and are sent directly to a filter press where the solid sodium chloride is removed. This press has about fifty plates and frames.

These quaternary ammonium compounds are marketed by Armour under the trade-mark Arquads, and are produced in mixtures of mean molecular weights ranging from 264 to 585. They are dispersible in water or alcohol and those of higher molecular weight in some organic solvents. They are cationic surface-active agents and possess strong batericidal and fungicidal activity.

Arquads (alkyltrimethylammonium chlorides) are solids having no definite melting point. This is readily explainable because the fatty acids from which the amines are prepared are not completely separated during their processing. Thus, a mixture of amines will produce a mixture of quaternary ammonium salts. Generally speaking, Arquads begin to soften at 70°C and decompose at about 180°C. Armour manufactures seven of these mixtures of compounds.

At the present time, there are probably not more than 100 cationic detergents available on the market, but the industry is rapidly expanding. Out of the research laboratories of companies and universities throughout the world, we may expect to find three types of improvement: (1) improvements in the conventional type of detergent today; (2) improvements by adding properties not now possessed by synthetic detergents; and (3) changes in physical form.

STRESS and STRAIN...

In an industrial engineering exam last spring the following question was asked; "Who are (or were) the Gilbreths?" One young ME answered thusly:

The Gilbreths were motion and time study experts. They had twelve children.

My parents told me not to smoke;
I don't.
Or listen to a dirty joke;
I don't.
They make it plain I mustn't wink
At pretty girls or even think
About intoxicating drink;
I don't.
Wild youths chase women, wine, and song;
I don't.
I've kissed no girls, no, not a one;
I do not know how it is done;
You wouldn't think I have much fun
I DON'T ! ! !

Father: If I ever catch you with my daughter again, I'll shoot you.

Young man: I'll lend you the gun.

To woman; the only loved autocrat who elects without voting; governs without law; and decides without appeal.

Student: Have you any four volt, two watt bulbs?
Clerk: For what?
Student: No, two.
Clerk: Two what?
Student: That's right.

Coed: Darling, would you still think I was beautiful if I didn't wear all these nice clothes?

ChemE: Let's decide that question now!

All the animals boarded Noah's ark in pairs—all except the worms, who came in apples.

The ME at work with a saw and hammer when his neighbor came over.

"How's the wife?" he asked.

"Pretty sick."

"That her coughin'?"

"Hell no—this is a dog house."

And then there's the farmer who was looking for the needle in the haystack because that's where his daughter did all her fancy-work.

A minister, while visiting one of his flock who had been a sailor, heard the parishioner's parrot make a few remarks in the way that only a sailor's parrot can. Very much embarrassed, the ex-sailor apologized. The minister said that he had a parrot which prayed all the time, and made the suggestion that his parrot might be a good influence on the sailor's bird. The sailor agreed and so the minister brought his parrot over the next time to spend a while with the other bird.

When the sailor's parrot saw the addition to his cage, he immediately remarked, "How about a little loving, baby?"

And the other answered, "What the hell do you think I've been praying for all these years?"

Many a sober-faced lamb goes riding in the moonlight and comes home with a sheepish grin on her face.

I serve one purpose in this school
On which no man can frown.
I quietly sit in every class
And keep the average down.

The Good Samaritan

What's happened to good old Atlas?
He took it on the lam,
And left his world supporting job
To good old Uncle Sam.

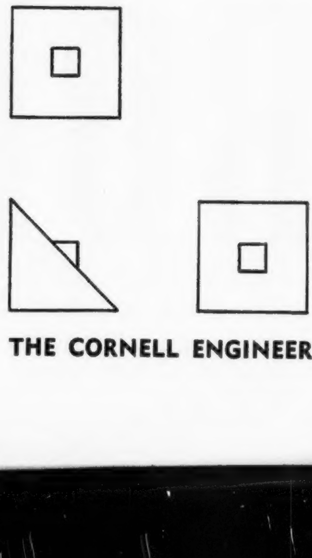
BRAIN TEASER:

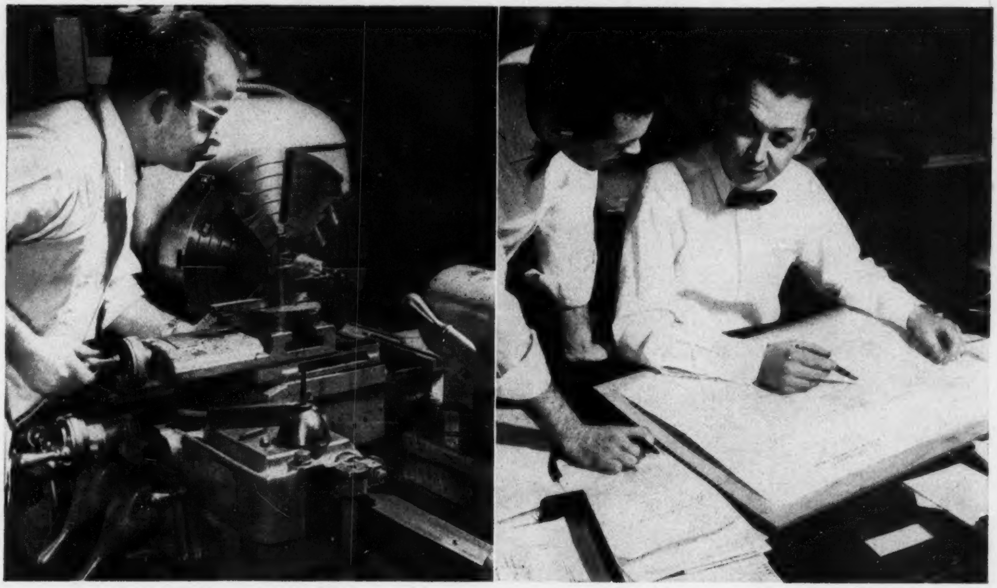
With many apologies, we'd like to correct the answer given to the SEND MORE MONEY brain teaser of the December issue. Our chief problem-solver must have been asleep at the switch, but John C. L. Fish, C.E. '92 sent us the correct answer:

$$\begin{array}{r} 9567 \\ 1085 \\ \hline 10652 \end{array}$$

Here is this month's brain teaser: A car going 30 mph leaves Ithaca headed for Geneva, a distance of 45 miles away, exactly as a car leaves Geneva for Ithaca going 15 mph. At the time that the car left Ithaca, there had been a bee sitting on the hood ornament, but he took off, and flying at 50 mph, he flew up the road to Geneva, where he met the car coming from Geneva, whereupon he reversed his direction, and flew in the direction of Ithaca, until he met the car coming from Ithaca, and reversed his direction once more, etc. The problem: How far had the bee flown by the time the two cars passed each other?

Answer to last month's brain teaser:





The Program includes assignments in machine operation and production functions.